Railway Mechanical Engineer

Volume 97 April, 1923 No. 4

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SOME INTERESTING ARTICLES IN FUTURE ISSUES

COMPETITION ON CAR INSPECTION

The results of the competition on Car Inspection, which closed March 30, will be given in the May issue.

COMPETITION ON ERECTING SHOP WORK

A new competition on Erecting Shop Practices has been announced. Articles must be mailed before June 1.

PUBLISHED ON THE FIRST THURSDAY OF EVERY MONTH BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY

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Entered at the Post Office at New York, N. Y., as mail matter of the second class.

Request for change of address should reach the New York office two weeks before the date of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, be sure to send us your old address as well as the new one.

Subscriptions, including the eight daily editions of the Railway Age, published in June, in connection with the annual convention of the American Railway Association, Mechanical Division, payable in advance and postage free: United States, Canada and Mexico, $3.00 year; elsewhere, $4.00, or £1 0s. 0d. a year. Foreign subscription may be paid through our London Office, 34 Victoria Street, S. W. 1, in £ s. d. Single copy, 35 cents.

WE GUARANTEE, that of this issue 8,200 copies were printed; that of these 8,200 copies, 7,230 were mailed to regular and paid subscribers; 23 were provided for counter and news company sales; 189 were mailed to advertisers; 15 were mailed to employees and correspondents, and 743 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 34,100, an average of 8,525 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulation (A. B. C.)

Railway Mechanical Engineer

Volume 97 April, 1923 No. 4

Wake Up! Erecting Shopmen

While it would be untrue and unfair to insinuate that erecting shop foremen and men are asleep on the job, the fact remains that they say nothing—at least for publication. Probably the things they say when driving wheels tram out-of-square after the binders are put on are not fit for publication. Be that as it may, erecting shopmen are going to have a chance to say something about their work through the columns of the *Railway Mechanical Engineer* and be paid for the trouble. An erecting shop competition has been inaugurated with a first prize of fifty dollars and a second prize of thirty-five dollars for the best articles dealing with erecting shop practices that are received before June 1, 1923. The articles may be of a general nature, or may cover some special phase of erecting shop work, such as stripping locomotives, distributing material to the various shop departments, bolting frames and cylinders, lining shoes and wedges, maintaining superheater units, handling truck repairs, assembling motion work, wheeling, valve setting, or, in fact, any work ordinarily done by erecting shopmen. The articles will be rated according to the practical value of the method described and the ideas presented and not on the basis of literary merit. It is hoped that every erecting shopman who has developed some method which saves time or labor in handling his work will take this opportunity of presenting his idea to other shopmen to their advantage and, incidentally, to his own. In addition to the prizes mentioned above, any other articles accepted for publication will be paid for at regular space rates. Articles entered in this competition should be mailed to the Managing Editor, *Railway Mechanical Engineer,* New York City, early enough to reach our office on or before June 1.

The Locomotive Engineer of the Future

Practically all railroad mechanical department officers seem to agree that securing proper operation of locomotives by the engine crews is constantly becoming a more serious problem. Modern motive power has practically all the features of a stationary power plant, and to operate it properly a man should have fully as much knowledge as is required of a licensed stationary engineer. Over and above all this the locomotive engineer must be thoroughly familiar with the details of train operation. The position is one which demands more than ordinary ability. Fifteen or twenty years ago men of inherent ability, who took a deep interest in their work, were attracted to the position of engineer. Today the same class of men are not available. Most young men shun hard work and while many of them would like to become engineers, they do not have enough stamina to spend several years as a fireman. When mechanical stokers come into more general use, this condition will be changed, but the number of locomotives now equipped with stokers is comparatively small.

The tendency toward increased complication in motive power, combined with a lowering of the standard of employees in engine service, is creating a serious condition. Unlike the new recruits of fifteen or twenty years ago, the average fireman today spends little time outside his regular hours of employment perfecting his knowledge of locomotive construction and operation. Many roads have gradually made the examinations for promotion less stringent and instead of requiring complete familiarity with the latest types of power, the fireman is considered as qualified to run a locomotive even if he has less knowledge that was required of the men who ran the old plain engines.

There is no escaping the fact that the average fireman of today is not a promising candidate for the position of locomotive engineer. There are two ways in which the railroads can improve this condition, both of which should be used. First, firemen should be instructed and examined periodically to make sure that they are acquiring a thorough knowledge of the modern locomotive. Second, everything within reason should be done to reduce the physical effort of the fireman, so that the position will no longer be referred to as demanding only a strong back and a weak mind.

Increasing Importance of Terminals

While the average locomotive may spend only eight hours a day in actual road service, most locomotive terminals must be operated twenty-four hours a day to care for them. Delays at terminals not only interfere with traffic schedules, but undue time spent on ash pits, in coaling, inspection, boiler washing, or in performing running repairs makes necessary the purchase of additional locomotives to handle the traffic. Unfortunately, many terminals were planned in the days when motive power was much lighter than at present and at a time when cranes and other labor-saving devices were of relatively far less importance. Not only have the parts of the modern locomotive increased considerably in weight, but the increasing importance of greater economy in operation has made it desirable to improve the locomotive by the addition of many devices not formerly used. All of this, however, has added largely to the work required at terminals, for without proper maintenance the full value of many locomotive improvements will not be realized.

In addition, most roads have adopted the plan of making many repairs in the terminal which were formerly done in the back shop. This practice is advantageous in that the mileage between shoppings is thereby lengthened and some relief is obtained for the main shops which have in too many instances been outgrown. In order that the locomotive terminal may properly perform its functions of promptly returning locomotives to the operating department and of rendering the maximum relief to the main shop, it must receive more attention than hitherto has been given to it. Adequate provision must be made for light, ventilation and labor-saving equipment so that both day and night work may be performed under conditions which will render employment

less undesirable and much more efficient. Above all, the terminal shop must be provided with better machine tools and of a greater variety. The use of antiquated tools and makeshift devices is too heavy a burden for the railroads to carry much longer. Mechanical department officers who are responsible for locomotive terminal operation and best know the needs of the place can aid greatly towards reducing operating expenses by vigorously advocating needed improvements in layout and equipment of terminals.

Draft Gear Maintenance

When heavy steel underframes were first applied to freight cars, the draft attachments remained in good condition for long periods with very little attention. It seemed for a time that one of the largest items of the cost of car repairs had been almost eliminated, and to a certain degree this was actually the case. However, at the present time defects in draft gear and draft attachments seem to be increasing very materially. If operating conditions are considered, it is easy to see why this period of freedom from failure was only temporary. As long as a considerable proportion of wooden cars were in use this weak equipment absorbed the shocks and protected the steel cars. Now that practically all the cars are of steel, or have steel underframes, shocks are not dissipated as well and high stresses are set up. Furthermore, the tractive force of locomotives has increased rapidly without a corresponding increase in the strength of cars. The present A. R. A. recommendations call for a draft gear of 150,000 lb. capacity. It is not uncommon to find trains handled by two locomotives, each exerting 75,000 lb. tractive force.

It is desirable to keep the capacity of the draft gear well above the forces to which it is subjected because if the gear goes solid, the stresses in the car increase with extreme rapidity. The full capacity of a draft gear can only be developed when it operates at its maximum travel, and for that reason lost motion in the gear should be carefully avoided. Slack in the attachments should not be neglected, because it permits variations in speed between adjacent cars which increase the shocks when the slack is suddenly taken up. An examination of cars in ordinary service will almost always show that a large proportion of them are not in condition to dissipate shocks effectively, and even though this fact is recognized, the parts are usually allowed to run until a complete failure makes repairs absolutely necessary. It would be very convenient if the railroads could put on draft gear and attachments and then forget about them, but with failures becoming more numerous, it is a question whether it would not be cheaper to bring these parts up to standard at regular intervals.

Safety First

The number of accidents in railroad shops has been greatly reduced in recent years owing to the commendable work of Safety First committees and the general educational programs which have been inaugurated. There is still opportunity for improvement, however, and one of the points deserving particular attention is the number of eye accidents. Eye accidents are more numerous than any others particularly in blacksmith shops owing to the flying scale, hot steel chips and emery dust. Forging machines and drop hammers add to the hazards and hot saws send showers of sparks in all directions. The obvious solution is to get the men to wear goggles, but this is easier said than done. Possibly the experience in a large Canadian forge shop may be of interest and suggestive value. With eye accidents on the increase the management decided to overcome objections to the wearing of goggles as much as possible and make goggle wearing compulsory.

The objection that goggles are heavy is reasonable but unavoidable if they are to be strong. When properly fitted the weight is not noticed. When goggles cause headaches the chances are that the lenses are not perfectly flat or colorless, or possibly the eyes are defective. The wearer must have lenses suited to his individual needs inserted in the regulation protective goggle frame. Experience shows that goggles are not hot to wear but in fact protect the eyes from furnace heat and flying articles. Should the middle frame get hot, a bit of cloth in extreme cases can be sewed around the bridge. Will not steam, water and oil fog the lens? Assuredly, and the answer is to wipe it off. Anyone who wears eye-glasses must perform this simple operation which does not interfere with production to any practical extent. A small amount of glycerine soap rubbed on the lens and wiped off with a clean cloth will help reduce fogging. For men who work on very hot jobs it may be necessary to stretch a cheese cloth pad across the forehead with an elastic band to prevent perspiration from running down into the eyes.

Coaxing, pleading and arguing will do no good unless the shop managements take a definite stand and enforce rules for the wearing of goggles on jobs subject to eye hazards. The matter is important since accidents from this cause cost the railroads large amounts of money annually in doctors' bills, damages, loss of service and loss of production. As demonstrated by the experience of the Canadian forge plant, the obvious thing to do is to overcome objections to the wearing of goggles and make their wearing compulsory. There is no question that on many jobs production will actually be increased since men can work both better and faster when they do not have to be continually on guard against dust, chips or scales flying into their eyes.

Responsibility for Damage to Cars

RULE 32 is probably the cause of as many appeals for arbitration as all of the other car interchange rules combined. To a considerable extent the difficulty of administering this rule is inherent in the conditions covered by the rule itself. Indeed, evidence that this is true is contained in the number of cases in which the Arbitration Committee is called on, not so much in its capacity as an interpreter of the rule as to decide disputed questions of fact. With the responsibility for extensive damage determined by the effect rather than the cause, questions of fact are readily established. It is comparatively simple to determine the condition of a damaged car, but the circumstances connected with the damage a knowledge of which is necessary to determine the cause, are seldom established beyond all doubt and many times are not ascertainable at all.

But some of these appeals for arbitration appear to arise from a failure to appreciate the principles underlying this and the other rules related to it as they now stand in the interchange code and as they are being interpreted in its decisions by the Arbitration Committee. Since 1914 there has been a complete change in the construction of the rules bearing on the determination of responsibility for damage to equipment. This change began with the elimination of the so-called combination defects, by which handling line responsibility was defined, and continued with the gradual development in Rule 32 of definitions of the specific causes of accidents which mark the damage as handling line responsibility irrespective of its extent. The former rules protected the car owner in the perpetuation of obsolete and unfit equipment and penalized the handling line unfortunate enough to have to move cars of this character. The present rule offers far greater protection to the handling line against damage caused primarily by the weakness of the equipment than the former combination defects.

But the decisions of the Arbitration Committee in cases arising under Rule 32 show a tendency, if not a deliberate

rule of action, to assume that the existence of any of the conditions listed in the rule is proof that this condition is the primary cause of the damage. This conclusion does not always follow, particularly in cases where derailment, wrong signals or no rider protection are reported as attendant circumstances. There are cases of damage for which this strict interpretation of the rules makes the handling line responsible, where equipment of better construction undoubtedly would not have failed.

Before deciding that this tendency is inconsistent with the principle of the rule, however, it must not be forgotten that the owner is entitled to some consideration, and that, in settling questions as to responsibility for damage the owner is at a decided disadvantage because he has no first-hand knowledge of the conditions under which his car was damaged. It is logical, therefore, that in establishing the facts of each case in which owner's responsibility is claimed, the burden of proof be placed on the handling line and a strict interpretation of the rule in favor of the owner is justified. Furthermore, a policy of liberal interpretation of the rule in favor of the handling line, requiring the consideration of such circumstances as the general condition of the damaged car prior to the accident, or the complete escape from damage of other cars associated with it and apparently more directly subjected to excessive stresses, would tend to throw every case arising under Rule 32 into the hands of the Arbitration Committee before a settlement could be effected.

As the matter stands, then, the handling line is protected if it can show a case in which clearly none of the conditions named in Rule 32 exist, but it has little prospect of a favorable decision unless it can demonstrate beyond reasonable doubt that its hands are absolutely clean.

New Books

Proceedings of the Traveling Engineers' Association. 323 *pages, 6 in. by 8½ in., bound in leather. Published by the association, W. O. Thompson, secretary,* 1177 *East Ninety-eighth street, Cleveland, Ohio.*

This is the report of the Thirtieth Annual Convention, held in Chicago October 31-November 3, 1922. The subjects discussed included: Distribution of power; advantages of self-adjusting wedges, feedwater heaters and boosters; employing, educating and examining engineers and firemen; air brake defects; mechanical firing and operation and maintenance of oil-burning engines.

Metals and Their Alloys. *By Charles Vickers,* 800 *pages,* 6 *in. x* 9 *in.,* 110 *illustrations, bound in cloth. Published by Henry Carey Baird & Co., New York.*

Although partly based on Metallic Alloys by William T. Brannt, the revision has been so thorough and so much new material has been included that this volume is practically a new work. It is a comprehensive and practical reference book on the subject of metals and their alloys, and will be of special interest to the engineer, designer, metallurgist, chemist, and foundryman. It deals with the origin of metals, their combination into various alloys and their physical properties, such as strength, ductility, hardness, bearing properties, lightness and resistance to acids. Modern American foundry practices are well described, although the book is not essentially one on foundry work. Information in regard to smelting and refining is somewhat brief and includes only such facts as the user of alloys would be apt to desire.

Considerable space is devoted to brasses and bronzes—copper, tin, lead, zinc, aluminum, manganese and other alloys. There are chapters on alloys for steam metals, bearing metals, solders and fusible alloys. Iron and steel alloys are covered briefly. There is also an interesting chapter on nickel alloys and monel metal. Sand casting, die casting and rolling are described. A glossary of foundry and other terms, also an excellent index, complete the book and add to its value.

What Our Readers Think

The St. Paul Gondola Car Design

Chicago, Ill.

To the Editor:

In the January issue of the *Railway Mechanical Engineer* on page 4 are some comments on the design of the C. M. & St. P. gondola cars described in an article in the November issue. The calculations on which the article was based were a preliminary study and before the cars were actually built several revisions were made.

Your correspondent criticised the use of the strut formula $16{,}000 - 70\frac{l}{r}$ as the product $\frac{l}{r}$ exceeded 120. The values given were materially decreased in the actual design and the stresses reduced to usual practice.

In connection with the bulging stresses imposed upon the side framing of the car, the correspondent apparently overlooked the fact that the internal gusset plates, posts and side braces are designed to withstand these bulging forces. When designing railway equipment, past experience naturally must form the foundation for the design and the calculations are more or less a check on designs already tested out and in actual service. In most cases it is found that theory and practice very closely agree. In the design of these cars both theory and practice were carefully considered in connection with the bulging stresses, as both the direct bulging stresses and the centrifugal forces were taken into consideration. This was not done, however, as suggested by the writer of the letter in your January issue. An open type car must be considered in the same manner as an open water tank. In our particular case, the side planks, which are 2¼ in. thick, are amply strong to distribute the stresses to posts, braces and gussets and there is no appreciable bulging strain in the top chord of the side framing. The only load on this member is produced by the material resting directly against it.

L. K. Sillcox,

General Superintendent, Motive Power, C. M. & St. P.

Drafting the Locomotive

Council Bluffs, Ia.

To the Editor:

The practice of utilizing the entraining action of the exhaust steam from the cylinders of the steam locomotive for the production of draft is universal. It is one of the features of locomotive design that has undergone little modification. As to its sufficiency for the purpose there is no question. As to the efficiency of its ordinary application there is much to be desired.

The writer inclines to the belief that the exhaust will continue to be so used to the exclusion of any other method. In the first place, the exhaust steam must be disposed of. Not to exceed 15 per cent of it may be utilized in a feedwater heater. It has been proposed to operate locomotive condensing, and while turbine driven locomotives are in operation with condensing equipment it would be extremely difficult to design and apply a condenser which would handle the volume of steam used by the modern reciprocating locomotive of large power, even after making allowance for reduced consumption when operating condensing.

The efficiency of the use of exhaust steam for the creation of draft is a field which offers splendid possibilities for investigation and research. The radical defect of practically all drafting arrangements is the necessity for carrying high

back pressure. This ranges from 10 lb. to 24 lb. and the power represented is considerable, over 1,000 hp. with large locomotives. This is many times the power that would be required to provide the draft if it were produced by an exhaust fan of even moderate efficiency.

The exhaust jet is an entraining device with an action somewhat similar to the steam injector.

The exhaust jet to produce draft has only to move the gases of combustion against a pressure of 6 in. to 8 in. of water, that being the difference between the pressure within the front end and atmospheric pressure outside.

There are certain variable conditions affecting the working or entraining action of the exhaust jet. These are: First, the velocity of the steam in the jet; Second, the size and form of the jet and the surface area exposed to contact with the gases of combustion; Third, the continuity of the jet, made up as it is of separate exhaust impulses.

Velocity is the only one of these variables which is given much attention. Increasing the velocity enhances the entraining action. Thus the first remedy when a locomotive fails to "steam" is to apply a smaller nozzle tip. The back pressure is increased, but the steam expanding from a higher pressure has added velocity and an increased draft is the result. The loss of power from the increased back pressure tends to offset the gain, so that increasing the velocity in the jet by raising back pressure is a wasteful procedure.

Steam on expanding performs work whether it expands against a moving piston or in an exhaust nozzle. In the latter case the work performed is the production of velocity in the steam causing it to move against the pressure of the atmosphere. Knowing the pressure of the steam at the beginning of expansion and at the termination it is possible to determine the theoretical velocity.

The formula for ascertaining the velocity is as follows:

$$V = 223.8 \sqrt{H_1 - H_2}$$

In which V = Velocity in feet per second.
H_1 = Total heat in steam at beginning of expansion.
H_2 = Total heat in steam at end of expansion.

If the formula be worked for steam at 5 lb., 10 lb. and 20 lb. gage pressure, expanding in each case to atmospheric, the velocities will be found to be

5 lb. ...... 539 ft. per sec.
10 lb. ...... 705 ft. per sec.
20 lb. ...... 917 ft. per sec.

which covers the range of pressures ordinarily met in the exhaust jet. It will be seen that increasing the pressure 300 per cent only increases the velocity about 70 per cent. The formula is based on dry steam and adiabatic expansion and the velocities are the theoretical velocities, actual velocities being of course less. It is therefore clear why attaining increased velocity in the exhaust jet by increasing back pressure is an expensive remedy.

Now consider the second variable, the size and form of the jet. With two jets of equal velocity, the one which exposes the greater surface to contact with the gases will entrain a larger volume. Compare for instance a single jet with a cross sectional area at the nozzle of 30 sq. in. and two jets with an area of 15 sq. in. each. Assume that the velocity is equal and that the amount of steam discharged by the two smaller jets equals that of the larger one. The two smaller nozzles will expose a surface area 40 per cent greater than the single large nozzle and therefore should entrain and move a correspondingly larger volume of gases.

The single round nozzle jet is that form which provides the minimum surface area in the jet for a given cross sectional area. It would therefore appear that it is the least desirable form to use, if this second variable has any considerable bearing on the efficiency of the nozzle.

Now comes the third variable, continuity. The exhaust steam comes to the nozzle in separate impulses. As the speed of the locomotive increases the interval between impulses lessens, until at high speeds the flow of steam through the nozzle becomes almost continuous. The separate exhausts are still distinctly audible but the action on the fire indicates that the flow of air through it is almost continuous. Under such conditions the draft is all that can be desired, the disturbance of the fire is a minimum and the production of cinders much reduced. Could the exhaust pulsations be smoothed out and a greater degree of continuity secured at moderate speeds, much will be gained in the production of draft and fuel losses lessened.

The duty of the boiler is to furnish sufficient steam to develop the rated power of the locomotive. If coal is used for fuel, an amount must be burned that will furnish the desired heat to produce the steam, making due allowance for the boiler efficiency. The combustion of coal—composed of fixed carbon, volatile hydro-carbons, hydrogen, sulphur moisture and ash—is an intricate chemical reaction. To simplify matters only the combustion of the carbon portion of the coal will be considered.

If the carbon is completely burned in the presence of sufficient air, carbon dioxide or CO_2 is formed. Theoretically 11.58 lb. of air are required to burn a pound of carbon to CO_2 if each carbon atom is supplied with the necessary pair of oxygen atoms with no excess of either. Owing to conditions under which combustion takes place in the firebox it is impossible to insure complete combustion if only the right amount of air is supplied and it is therefore necessary to introduce an excess of air to provide surplus oxygen. It has been found that by admitting an excess of 33 per cent combustion will take place with the formation of little or no carbon monoxide or CO. Therefore it is customary to supply about 16 lb. of air for each pound of coal burned.

When insufficient air is supplied part of the carbon is burned with the formation of carbon monoxide or CO. The heat produced in the formation of CO is 4,380 B. t. u. per pound. If the combustion takes place in the presence of sufficient air and CO_2 is formed, the heat produced is 14,540 B. t. u. per pound. If the fire is starved for air, the heat produced will be less and the boiler efficiency will fall off rapidly. High rates of firing, exceeding 120 lb. of coal per square foot of grate per hour, are wasteful for the simple reason that it is impossible to get enough air through the fire to secure complete combustion.

Larger grate areas are needed, larger openings for air through ashpans and to the space under the grates. It may be advisable to apply forced draft, preferably through hollow grate bars and especially through hollow arch tile if it can be arranged, in which case the air would be preheated to a degree. Air admitted above the grates is a detriment if enough can pass through the grates and the fire.

Although the modern locomotive has a large grate area, the rate of fuel consumption has been pushed up to as high as 150 lb. per square foot per hour. The volume of products of combustion handled by the draft is large and would be still greater if the proper amount of air were supplied.

Fuel rates of four or five tons of coal per hour are common for a modern freight locomotive. As the ash in the coal is not dealt with by the draft, assume that four tons or 8,000 lb. of combustible are burned per hour. If 16 lb. of air are supplied per pound of coal there must be passed through the fire 128,000 lb. of air per hour. As the coal consumed is added to the above the total of products of combustion is 136,000 lb. of flue gases.

There should be 9 lb. of steam produced for each pound of combustible or a total of 72,000 lb. of steam per hour. Assuming that the feedwater heater, air pump, and other auxiliaries account for 16,000 lb. hourly, there remains then 56,000 lb. exhaust steam to be used in producing draft.

That the figures may be more readily grasped, it may be better to reduce them to pounds and cubic feet per second. The weight of gases per second becomes 37.77 lb. and of steam, 15.55 lb. This is an average rate—the momentary maximum rate may be much greater. As one cubic foot of flue gas at a temperature of 650 deg. F. weighs .03764 lb.,

the total volume of the 37.77 lb. of flue gas will be 1,000 cu. ft., approximately. If the exhaust steam is expanded to atmospheric pressure, its volume will be 15.55 $\times$ 26.27 = 400, approximately, the figure 26.27 being the specific volume of steam at atmospheric pressure. The total volume of steam and gases combined becomes about 1,400 cu. ft. per sec.

The locomotive under consideration will have a stack about 18½ in. in diameter at the choke or an area of 1.862 sq. ft.

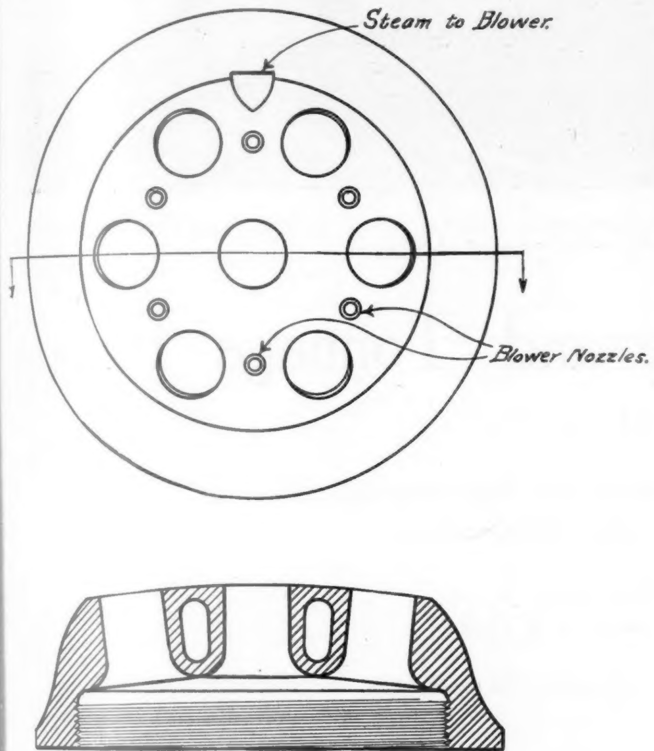


Fig. 1—Suggested Nozzle Cap

Dividing the total volume—1,400 cu. ft.—of gases and steam passing per second by the area of the stack will give the velocity at which they are moving, as 752 ft. per sec. Now, referring to the paragraph on expansion of steam at 5, 10 and 20 lb. pressure, it will be observed that 10 lb. pressure is too low to produce the velocity required to move the gases at 752 ft. per sec.

Suppose that the stack diameter be increased to 30 in. with an area of 4.9 sq. ft. In that case the velocity of the gases would equal 286 ft. per sec. This is reduced to a figure where steam at a much lower pressure will serve the purpose.

It was shown that two jets should be more effective in entraining action than a single jet of an equivalent area. Carry this idea farther and increase the number of jets to seven, making them all of equal size, placing one centrally and spacing the remaining six equidistantly around it. Proportion the jets to secure lower back pressures by making their total area of opening more than that of the single jet. Make each individual nozzle or orifice of the most approved form, i. e., what is known as the ideal low pressure nozzle, except that the cylindrical bore is lengthened a little to secure positive direction to the jet. The entrance of the individual nozzles is rounded by an easy curve, a radius of at least one half the nozzle diameter. Form the entire group in a single casting made in the form of a small segment of a sphere, the individual nozzles being radial or normal to the surface. The jets will be given a slight spread, sufficient to fill the larger stack and the entire space between jets for a considerable portion of the exposed length will be available for entraining action.

If these ideas are embodied in a drawing, the nozzle will appear as shown in Fig. 1. A blower connection has been provided by coring out the interior of the nozzle cap casting and inserting nozzles in the spaces between the main nozzles.

Fig. 2 is a cross section through the front end and shows the form of the nozzle and stack, the form and direction of the steam jets being indicated by broken lines. It also shows another feature intended to secure greater continuity in the flow of the exhaust steam, that of a receiver, secured by enlargement of the exhaust passage ways, these being merged into a single large central chamber at a point near the bottom of the saddle casting.

By breaking up the exhaust into several distinct and separated jets, the entraining surface area is increased to 300 per cent of that of a single jet. The space between jets should be especially effective, the gases therein being exposed on all sides to the moving steam. The radial direction of the jets should maintain this spacing for such a distance as may be required and also enable the steam to fill a larger diameter stack sufficiently to exclude any possibility of back draft.

The writer believes that it has been made clear that the necessity for high back pressures in practically all existing designs is caused by adherence to the use of the single round

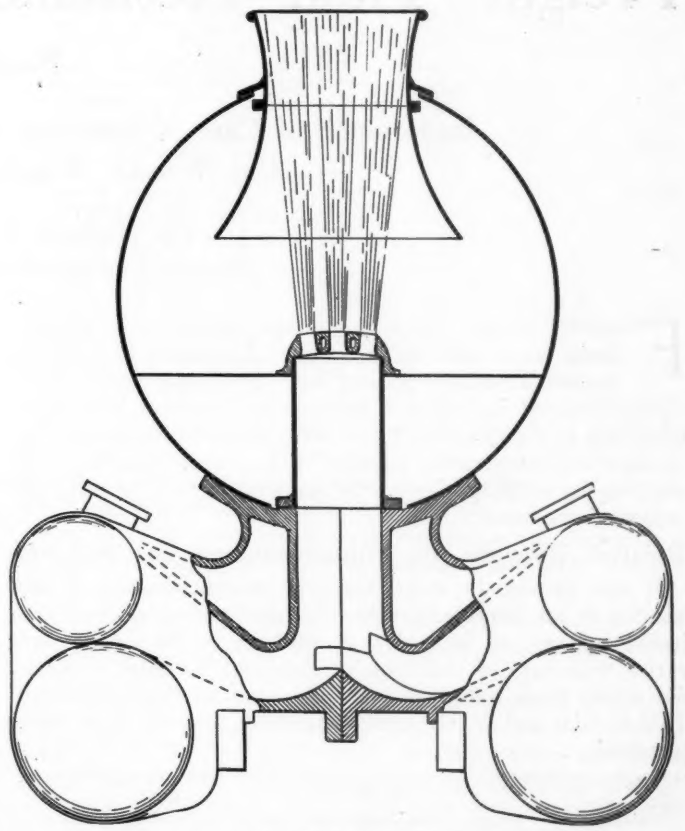


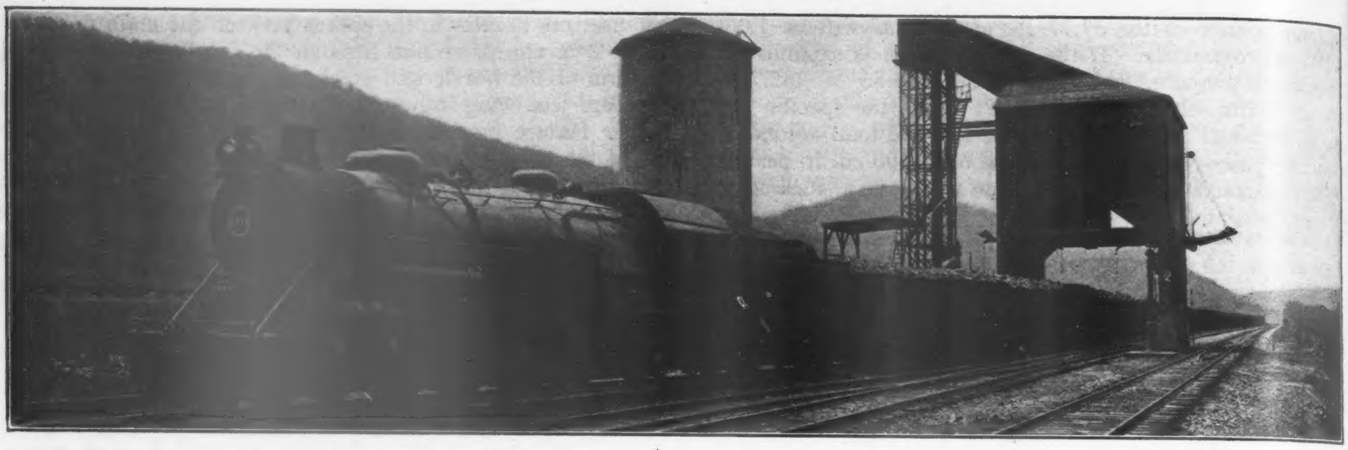
Fig. 2—Section Through Front End

jet which calls for a small stack and unnecessarily high exit velocities in the steam and gases passing through it.

The preponderating merit of the exhaust as a draft producer is its simplicity. That is a feature which it will be difficult to overcome, more so as the improvement of the steam locomotive advances and necessary complication increases in the addition of devices which make for greater economy. It is well therefore to retain the simplicity of this feature, provided its efficiency can be sufficiently increased.

The illustrations herewith, while showing a design which is believed to embody all the desirable features, including that of securing maximum continuity in the flow of steam, must not be construed to indicate that new cylinders are required on existing locomotives. A nozzle of the type shown can be designed for application to existing power which will produce good results although the continuity feature is not fully realized.

THOMAS E. STUART.



Baltimore & Ohio Coal Train—Sixty-three steel hopper cars (55 tons capacity) loaded with 3,351 tons of coal. Gross weight of cars and contents 4,586 tons. Mikado engine, weight 284,500 lb.—Tractive effort 55,000 lb.

Freight Train Resistance and Tonnage Rating

Part III

Importance of Care in Selecting Values for Adjustment—Effect of Car Weight, Weather and Temperature

By Richard J. McCarty, Jr.
Division Superintendent, Delaware & Hudson

FORMULAS for adjusted tonnage ratings have already been given and the necessary allowances for certain factors have been pointed out. The fundamental principles involved in adjusted tonnage ratings also have been taken up and analyzed. There now remain adjustments for weather and temperature together with a consideration of the relationship existing between the adjustment and the different values of resistance.

Relation Between the Adjustment and Car Weights

It was previously stated that the proper selection of car weights is an important matter in establishing efficient adjusted ratings, so in order to show how the adjustment varies with cars of different weights and in order to show the result when the adjustment does not fit the conditions, Tables VII and VIII, and Exhibits F and G have been prepared.

TABLE VII

COMPARISON OF ADJUSTMENTS BASED ON CARS OF DIFFERENT WEIGHTS
STRAIGHT AND LEVEL TRACK-SPEED 5 MILES PER HOUR

Items	Tons per car	Mech. resistance per ton	Mech. resistance per car	Grade resistance per car	Total resistance per car	Adjustment
Lighter car..	20	6.8	136	....	136	
Heavier car..	60	3.3	198	....	198	67.74
Difference ...	40	3.5	62	....	62	
Lighter car..	15	7.6	114	....	114	
Heavier car..	70	3.1	217	....	217	45.89
Difference ..	55	4.5	103	....	103	
Lighter car..	30	5.4	162	....	162	
Heavier car..	50	3.7	185	....	185	110.85
Difference ..	20	1.7	23	....	23	

NOTE—See Exhibit F.

These two tables and corresponding exhibits show that unless the car weights that are selected represent the conditions of operation, adjusted ratings based thereon are apt to cause trains to be over-loaded or under-loaded an amount which depends on how the average weight of the cars of any one train compares to the weights on which the adjusted rating was based. Therefore, it is important to select as a basis, car weights that will give the most accurate ratings for the class of traffic that is to be moved.

Relation Between the Adjustment and Different Values of Resistance

In cases where the actual tons and the adjustment are obtained by tests, the different units and the adjusted ratings will of course be consistent, provided the tests are properly conducted.

In cases where the adjusted ratings are calculated, the same values as are used for obtaining the actual tons should be used in obtaining the value of the adjustment, which insures the proper consistency for the adjusted ratings.

But in cases where the actual tonnage rating of only one train is obtained by test or where the value of the adjustment only is wanted, it is necessary to use great care in selecting values as a basis for the adjustment, for otherwise it might not fit the conditions.

With a view of bringing out these points more clearly, and for other purposes which will appear later, the value of the adjustment with respect to the different values of resistance by which it is produced will be analyzed.

TABLE VIII

COMPARISON OF ADJUSTMENTS BASED ON CARS OF DIFFERENT WEIGHTS
GRADE 1 PER CENT—SPEED 5 MILES PER HOUR

Items	Tons per car	Mech. resistance per ton	Mech. resistance per car	Grade resistance per car	Total resistance per car	Adjustment
Lighter car..	20	6.8	136	400	536	
Heavier car..	60	3.3	198	1,200	1,398	4.87
Difference ..	40	3.5	62	800	862	
Lighter car..	15	7.6	114	300	414	
Heavier car..	70	3.1	217	1,400	1,617	3.92
Difference ..	55	4.5	103	1,100	1,203	
Lighter car..	30	5.4	162	600	762	
Heavier car..	50	3.7	185	1,000	1,185	6.03
Difference ..	20	1.7	23	400	423	

NOTE—See Exhibit G.

As a basis for further analysis there will be used equations (34) and (35) which show the relations that exist between the adjustment and the fundamental values by which it is produced, while Tables IX and X show the same thing by specific figures instead of by formula. It should be understood, however, that the tables just mentioned are made up

of entirely arbitrary values, except where actual figures are specified, and that the only purpose is to further illustrate the theory of the adjustment, and to show how, with given car weights, it varies with different values of mechanical resistance.

From these tables, it will be seen that with any two given cars of unequal weight, the adjustment varies with the different values of mechanical resistance, unless the values of mechanical resistance are such that the ratio of the total resistance in pounds per ton of the lighter car, to the total resistance in pounds per ton of the heavier car is a constant quantity, in which case the adjustment would remain constant.

EXHIBIT "F"

Effect of a Given Adjustment on Various Trains of Different Weight Cars. Straight and Level Track—Speed 5 Miles Per Hour

Items (res. in lb.)	Trains to which adjustment applies		Adjustment for 20 and 60 ton cars applied to trains of other wt. cars				
Actual ratings and unit values:							
Tons per car	20	60	15	30	40	50	70
M. R. per ton	6.8	3.3	7.6	5.4	4.4	3.7	3.1
Grade res. per ton	....	....	....	....	....	....	....
M. R. per car	136	198	114	162	176	185	217
Grade res. per car	....	....	....	....	....	....	....
Actual tons	1,980	4,080	1,771	2,493	3,060	3,640	4,343
No of cars	99	68	118.1	83.1	76.5	72.8	62.0
Total M. res.	13,464	13,464	13,464	13,464	13,464	13,464	13,464
Total grade res.	....	....	....	....	....	....	....
Total all res.	13,464	13,464	13,464	13,464	13,464	13,464	13,464
The above trains on adjusted tonnage rating basis:							
Adjustment	67.74	67.74	67.74	67.74	67.74	67.74	67.74
Actual tons	1,980	4,080	1,578	2,665	3,225	3,689	4,414
Potential tons	6,706	4,606	7,108	6,021	5,461	4,997	4,272
Adjusted tons	8,686	8,686	8,686	8,686	8,686	8,686	8,686
No. of cars	99	68	104.9	88.8	80.6	73.8	63.1
Total all res.	13,464	13,464	11,993	14,391	14,190	13,649	13,683
Overload or underload:							
Actual tons	0	0	—193	+172	+165	+49	+71
Mech. res.	0	0	—1,471	+927	+726	+185	+219

EXHIBIT "G"

Effect of a Given Adjustment on Various Trains of Different Weight Cars. Grade 1 Per Cent—Speed 5 Miles Per Hour

Items (res. in lb.)	Trains to which adjustment applies		Adjustment for 20 and 60 ton cars applied to trains of other wt. cars				
Tons per car	20	60	15	30	40	50	70
M. R. per ton	6.8	3.3	7.6	5.4	4.4	3.7	3.1
Grade res. per ton	20.0	20.0	20.0	20.0	20.0	20.0	20.0
M. R. per car	136	198	114	162	176	185	217
Grade res. per car	400	1.200	300	600	800	1,000	1,400
Actual tons	502.4	577.9	487.8	530.1	551.8	568.1	582.8
No. of cars	25.12	9.63	32.52	17.67	13.79	11.36	8.32
Total M. R.	3,416	1,907	3,707	2,863	2,428	2,102	1,807
Total grade res.	10,048	11,557	9,757	10,601	11,036	11,362	11,657
Total resist.	13,464	13,464	13,464	13,464	13,464	13,464	13,464
The above trains on adjusted tonnage rating basis:							
Adjustment	4.87	4.87	4.87	4.87	4.87	4.87	4.87
Actual tons	502.4	577.9	471.6	537.3	556.8	569.0	583.8
Potential tons	122.3	46.8	153.1	87.4	67.9	55.7	40.9
Adjusted tons	624.7	624.7	624.7	624.7	624.7	624.7	624.7
No. of cars	25.12	9.63	31.44	17.91	13.92	11.38	8.34
Total resist.	13,464	13,464	13,016	13,647	13,586	13,485	13,486
Overload or underload:							
Actual tons	....	....	—16.2	+7.2	+5.0	+0.9	+1.0
Total resist.	....	....	—448	+183	+122	+21	+22

A study of these tables emphasizes the importance of having the adjustment based on the same values as were used in obtaining the actual tonnage ratings.

The mechanical resistance per ton for item A of Table IX are actual figures at 5 miles per hour as per Table II, while the values of mechanical resistance for items B, C, D, and E are hypothetical values used to illustrate the principles involved.

Item B is the same as A except mechanical resistance per ton for lighter car is increased and that for the heavier car is decreased.

Item C is the same as A except mechanical resistance per ton for lighter car is decreased and that for the heavier car is increased.

Item D is the same as A except mechanical resistance per ton for both cars increased an equal amount each.

Item E is the same as A except mechanical resistance per ton for both cars increased in the same proportion.

TABLE IX

Effect of Different Values of Mechanical Resistance on the Adjustment

Straight and Level Track—Speed 5 Miles Per Hour

	Items	Tons per car	Mech. resistance per ton	Mech. resistance per car	Grade resistance per car	Total resistance per car	Adjustment
A	Lighter car	20	6.8	136	....	136	
	Heavier car	60	3.3	198	....	198	67.74
	Difference	40	3.5	62	....	62	
B	Lighter car	20	8.0	160	....	160	
	Heavier car	60	3.0	180	....	180	300.00
	Difference	40	5.0	20	....	20	
C	Lighter car	20	6.0	120	....	120	
	Heavier car	60	4.0	240	....	240	20.00
	Difference	40	2.0	120	....	120	
D	Lighter car	20	8.0	160	....	160	
	Heavier car	60	4.5	270	....	270	38.16
	Difference	40	3.5	110	....	110	
E	Lighter car	20	10.88	217.6	....	217.6	
	Heavier car	60	5.28	316.8	....	316.8	67.74
	Difference	40	5.60	99.2	....	99.2	

TABLE X

Effect of Different Values of Mechanical Resistance on the Adjustment

Grade 1 Per Cent—Speed 5 Miles Per Hour

	Items		Total tons resistance per car per ton	Mech. resistance per car	Grade resistance per car	Total resistance per car	Adjustment
A	Lighter car	20	26.8	136	400	536	
	Heavier car	60	23.3	198	1,200	1,398	4.87
	Difference	40	3.5	62	800	862	
B	Lighter car	20	28.0	160	400	560	
	Heavier car	60	23.0	180	1,200	1,380	7.32
	Difference	40	5.0	20	800	820	
C	Lighter car	20	26.0	120	400	520	
	Heavier car	60	24.0	240	1,200	1,440	- 2.61
	Difference	40	2.0	120	800	920	
D	Lighter car	20	28.0	160	400	560	
	Heavier car	60	24.5	270	1,200	1,470	4.61
	Difference	40	3.5	110	800	910	
E	Lighter car	20	30.88	217.6	400	617.6	
	Heavier car	60	25.28	316.8	1,200	1,516.8	7.47
	Difference	40	5.60	99.2	800	899.2	
F	Lighter car	20	29.58	191.6	400	591.6	
	Heavier car	60	25.73	343.8	1,200	1,543.8	4.87
	Difference	40	3.85	152.2	800	952.2	

The mechanical resistance per ton for item A of Table X are actual figures at 5 miles per hour as per Table II, while the values of mechanical resistance for items B, C, D, E and F are hypothetical values.

Item B is the same as A except the mechanical resistance per ton for the lighter car is increased and that for the heavier car is decreased.

Item C is the same as A except the mechanical resistance per ton for the lighter car is decreased and that for the heavier car is increased.

Item D is the same as A except the mechanical resistance per ton for both cars is increased an equal amount each.

Item E is the same as A except the mechanical resistance per ton for both cars is increased in the same proportion.

Item F is the same as A except the total resistance per ton for both cars is increased in the same proportion.

Effect of Weather on Tonnage Ratings

The values of mechanical resistance that have been used up to the present point represent favorable weather conditions, but as the mechanical resistance of any given car or train at any given speed increases as the temperature decreases and as it is increased by wind and precipitation, it is necessary to introduce some method by which tonnage ratings can be modified to meet unfavorable weather conditions. This is one of the most important features in connection with tonnage ratings but is probably the least susceptible to an analysis of any practical value.

Obviously, if any classification of tonnage ratings is to be developed on account of weather conditions, it must be based on temperature.

The general practice in connection with adjusted tonnage ratings is to provide four classes of ratings and designate

them A, B, C and D, defining each class by temperature limits, the selection of which is principally a matter of judgment, although in some cases conditions might have something to do with it.

Master Mechanics' Proceedings for 1914, page 307, gives a diagram of the mechanical resistance of a light car and a heavy car at various temperatures which diagram reduced to a straight and level track basis gives values as shown in Table XI.

TABLE XI

TEMPERATURE LIMITS FOR WEATHER RATINGS AND EFFECT OF TEMPERATURE ON MECHANICAL RESISTANCE

Classification of ratings	Temp. limits (Fahr.)	Basis for each rating (mean temp.)	Per cent increase in mech. res. in lb. per ton: 20-ton cars	72-ton cars
A	Above 30 / 30	70 degrees	Basis	Basis
B	30 / 15	22.5 degrees	15	15
C	15 / 0	7.5 degrees	30	30
D	0 / −15	−7.5 degrees	55	55

These figures show that as the temperature decreases the mechanical resistance in pounds per ton increases in the same proportion for all axle loads.

A decrease in temperature raises the mechanical resistance in pounds per ton for both the locomotive and the cars, and therefore, the "A" rating must be reduced to an amount that will offset the decrease in drawbar pull that results from the increase in mechanical resistance—mainly journal friction—of the cars.

Of the different elements of locomotive mechanical resistance it is estimated that only 18 pounds per ton out of 25 per ton for the weight on the drivers is affected by temperature.

By increasing the elements of locomotive mechanical resistance susceptible to temperature according to the values in Table XI and using the values of equation (3) as a basis, the following formulas are obtained:

For A rating, $f = 200.56\ (254.6 - G)$ .... From (4)
For B rating, $f = 200.56\ (252.8 - G)$ .... (53)
For C rating, $f = 200.56\ (251.0 - G)$ .... (54)
For D rating, $f = 200.56\ (248.0 - G)$ .... (55)

These formulas can be used to calculate the drawbar pull of the locomotive specified in connection with equation (3) for any grade and any temperature within the limits prescribed by Table XI, but only for the locomotive specified, in connection with equation (3).

It is now in order to pass to the effect of temperature on train resistance exclusive of the locomotive.

By adding to the items of mechanical resistance in equation (37) and a similar equation based on the heavier cars, a co-efficient to represent the increase in this kind of resistance with a decrease in temperature as shown in Table XI the following equations are obtained:

Rating — Based on Equations (37) for Lighter Weight Cars

$$\text{A Adj. tons} = \frac{f}{1.00E + G} + CW\,(W + w)\,\frac{1.00e}{1.00r + d} \quad \ldots (56)$$

$$\text{B Adj. tons} = \frac{f}{1.15E + G} + CW\,(W + w)\,\frac{1.15e}{1.15r + d} \quad \ldots (57)$$

$$\text{C Adj. tons} = \frac{f}{1.30E + G} + CW\,(W + w)\,\frac{1.30e}{1.30r + d} \quad \ldots (58)$$

$$\text{D Adj. tons} = \frac{f}{1.55E + G} + CW\,(W + w)\,\frac{1.55e}{1.55r + d} \quad \ldots (59)$$

Rating — Based on an Equation for Heavier Weight Cars Similar to Equation (37)

$$\text{A Arj. tons} = \frac{f}{1.00\,(E - e) + G} + (C - c)\,W\,(W + w)\,\frac{1.00e}{1.00r + d} \quad \ldots (60)$$

$$\text{B Adj. tons} = \frac{f}{1.15\,(E - e) + G} + (C - c)\,W\,(W + w)\,\frac{1.15e}{1.15r + d} \quad \ldots (61)$$

$$\text{C Adj. tons} = \frac{f}{1.30\,(E - e) + G} + (C - c)\,W\,(W + w)\,\frac{1.30e}{1.30r + d} \quad \ldots (62)$$

$$\text{D Adj. tons} = \frac{f}{1.55\,(E - e) + G} + (C - c)\,W\,(W + w)\,\frac{1.55e}{1.55r + d} \quad \ldots (63)$$

in which the first part of each equation represents the actual tons and the second part the potential tons and the adjustment, as previously explained.

From these equations the following corollary may be deduced:

9—As between ratings for different rates of grade, the percentages of decrease of the B, C and D ratings compared to their corresponding A rating, are less as the rate of grade increases.

The reason for this is that tonnage reductions for weather conditions are based on temperature which affects only mechanical resistance and as mechanical resistance is only a part of the total resistance it follows that as the grade resistance increases the mechanical resistance becomes smaller in proportion to the total resistance, and, therefore, the effect on the tonnage of any increase in mechanical resistance by reason of temperature becomes less in proportion as the grade resistance increases.

In connection with the co-efficient of the adjustment in equations (56) to (63) inclusive it follows that when (d) is equal to zero,

$$\frac{1.55e}{1.55r} = \frac{1.30e}{1.30r} = \frac{1.15e}{1.15r} = \frac{1.00e}{1.00r} \quad \ldots (64)$$

From these ratios the following corollary may be deduced:

10—When mechanical resistance only is involved, the adjustment is constant for all temperatures.

The reason for this was explained in connection with Table IX items (A) and (E).

By referring to the co-efficient when grades are involved it follows that

$$\frac{1.55e}{1.55r + d}\ \text{is greater than}\ \frac{1.30e}{1.30r + d}\ \text{is greater than}\ \frac{1.15e}{1.15r + d}\ \text{is greater than}\ \frac{1.00e}{1.00r + d} \quad \ldots (65)$$

From these ratios the following corollary may be deduced:

11—When both mechanical and grade resistance are involved, the adjustment increases as the temperature decreases.

The reasons for this were explained in connection with Table X, items (A) and (E).

Table XII, which has been calculated by the part of equations (56) to (59) that applies to the adjustment, gives in specific figures an illustration of corollaries (10) and (11).

TABLE XII

Effect of Temperature on the Adjustment, Same Values as Tables III and IV

Grade and class of rating	Tons per car: Lighter car	Heavier car	Dif. in units of resist.: M. R. per ton	M. R. per car	G. res. per car	Total res. per car	Adjustment
By formula—	(W)	(W + w)	(e)	(r)	(d)	(r + d)	$\frac{t}{e}$
No Grade—							
A	20	60	3.50	62.0	0	62.0	67.74
B	20	60	4.025	71.3	0	71.3	67.74
C	20	60	4.55	80.6	0	80.6	67.74
D	20	60	5.425	96.1	0	96.1	67.74
Grade 0.5 Per Cent—							
A	20	60	3.50	62.0	400	462.0	9.09
B	20	60	4.025	71.3	400	471.3	10.25
C	20	60	4.55	80.6	400	480.6	11.36
D	20	60	5.425	96.1	400	496.1	13.12
Grade 1.0 Per Cent—							
A	20	60	3.50	62.0	800	862.0	4.87
B	20	60	4.025	71.3	800	871.3	5.54
C	20	60	4.55	80.6	800	880.6	6.20
D	20	60	5.425	96.1	800	896.1	7.26

By using in equations (56) to (63), the same values of resistance as were used to derive equations (41) and (42), a simple set of formulas may be derived for practical purposes, as follows:

RATING — LIGHTER CAR BASIS — HEAVIER CAR BASIS

$$\text{A} \quad \text{Adj. tons} = \frac{f\,(d + 272)}{(G + 6.8)\,(d + 62)} = \frac{f\,(d + 132)}{(G + 3.3)\,(d + 62)} \quad \ldots (66)$$

$$\text{B} \quad \text{Adj. tons} = \frac{f\,(d + 312)}{(G + 7.8)\,(d + 72)} = \frac{f\,(d + 152)}{(G + 3.8)\,(d + 72)} \quad \ldots (67)$$

$$\text{C} \quad \text{Adj. tons} = \frac{f\,(d + 352)}{(G + 8.8)\,(d + 82)} = \frac{f\,(d + 172)}{(G + 4.3)\,(d + 82)} \quad \ldots\ldots (68)$$

$$\text{D} \quad \text{Adj. tons} = \frac{f\,(d + 420)}{(G + 10.5)\,(d + 96)} = \frac{f\,(d + 204)}{(G + 5.1)\,(d + 96)} \quad \ldots\ldots (69)$$

According to corollary 11, which applies to practical conditions, the theoretical adjustment increases as the temperature decreases and therefore, to be consistent any B, C or D rating should each in order have a higher adjustment than that for any one of the preceding classes A, B or C.

By substituting in equation (36), which is the basic formula for the adjustment, the same values as were used in the derivation of the equations (66) to (69) inclusive, the formulas for the adjustment in simple forms are:

$$\text{For A rating:} \quad \text{Adjustment} = \frac{4200}{d + 62} \quad \ldots\ldots\ldots\ldots \text{From (47)}$$

$$\text{For B rating:} \quad \text{Adjustment} = \frac{4800}{d + 72} \quad \ldots\ldots\ldots\ldots (70)$$

$$\text{For C rating:} \quad \text{Adjustment} = \frac{5400}{d + 82} \quad \ldots\ldots\ldots\ldots (71)$$

$$\text{For D rating:} \quad \text{Adjustment} = \frac{6480}{d + 96} \quad \ldots\ldots\ldots\ldots (72)$$

In connection with corollary 11, it is well to remember that the heavier the grade is on any district the less important it is to recognize the increase in the value of the B, C and D adjustments resulting from lower temperatures. As was previously pointed out, over-adjustment of ratings that are otherwise correct results in underloading of trains, while under-adjustment causes overloading, both of which are uneconomical.

Theoretically it is necessary to have separate adjustments for A, B, C and D ratings if accurate ratings are desired. It is very desirable, however, for practical reasons to have only one adjustment for each set of ratings and as the lower temperatures are frequently accompanied by snow and strong winds which prevent the calculation of accurate ratings for such conditions and for which special allowances are necessary as circumstances require, the use of one adjustment is advisable. This can be arranged by making a special deduction from the calculated B, C and D ratings that will approximately off-set the use of the A rating adjustment with B, C and D ratings. For example, if 20-ton and 60-ton cars are used as a basis, the special amount to be deducted from any given B, C or D rating can be arrived at by taking the mean basis weight, or 40 tons per car, dividing it into the calculated adjusted rating to get the average number of cars of that rating and then multiplying that figure by the difference between the proper adjustment and the A rating adjustment.

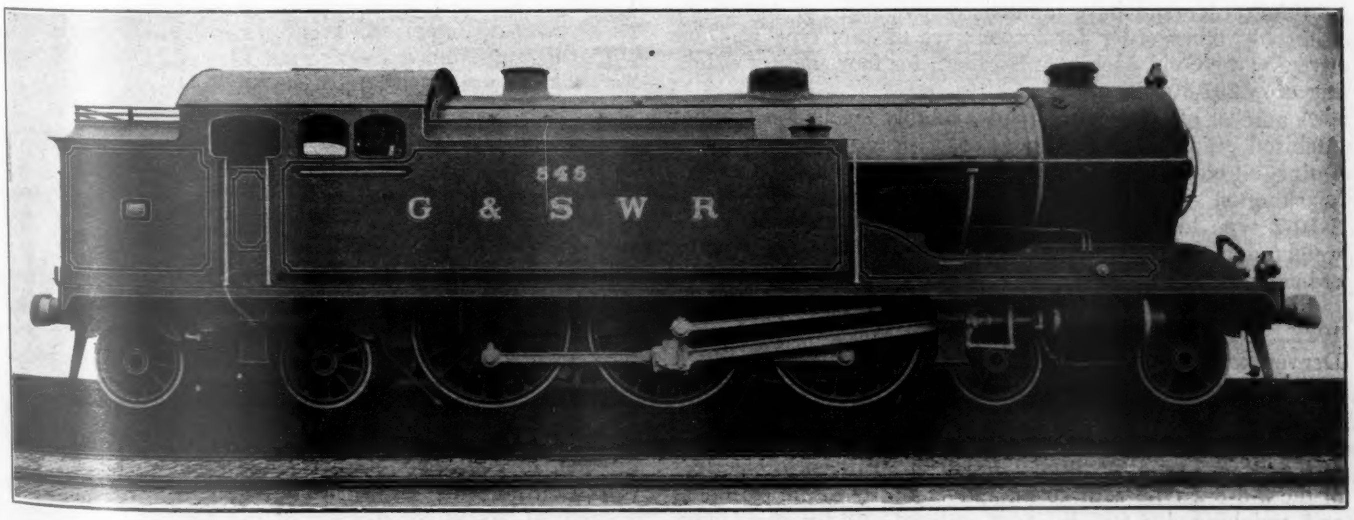
Although temperature ratings are necessarily theoretical they are very valuable as a basis for the judgment in deciding what should be done under different conditions of weather. All of those who have anything to do with deciding what ratings will be in effect at any time should thoroughly understand the principles involved in corollaries (9), (10) and (11), as the tendency even on heavy grade divisions is to make excessive special tonnage deductions for low temperatures and adverse weather conditions.

Conclusion

The advantage of the adjusted method is its simplicity and and ease of operation in yard and other offices. With only one adjustment in effect for each direction on any given district, it is an easy matter to add this amount to the weights of the cars as the train tonnage is added up.

As before stated, adjusted tonnage ratings are absolutely accurate only when trains are made up of the same weight cars as were used in obtaining the rating and the adjustment. Experience has shown, however, that the percentage of error with other weight cars is not large enough to seriously interfere with the efficiency of the method if the method itself is properly applied.

In this connection it is well to remember that in any adjusted tonnage rating, the adjustment should represent, in tons, the relative difference in mechanical resistance as between two cars of different weights selected as a basis and that the two cars so selected as a basis should represent as nearly as possible the traffic conditions on any division or district for which adjusted tonnage ratings are being calculated, and unless the adjustment correctly represents this condition, trains may be excessively overloaded or underloaded. Therefore, in any given district, a careful study of operating conditions should be made to see that the fundamental units on which the ratings and adjustments are based accurately fit the conditions.



Baltic Type Tank Locomotive for Glasgow & South Western Railway of England

In order to handle a rapidly increasing heavy traffic from Glasgow to the Ayrshire coast resorts the Glasgow & South Western placed in service last summer six of the most powerful tank locomotives in Great Britain. They were designed by Robert H. Whitelegg, chief mechanical engineer and locomotive and carriage superintendent of the road, and built by the North British Locomotive Company. They are intended for quick starting, rapid acceleration and high speed running. To facilitate operation in either direction all operating levers are duplicated on either side of the cab. The weight in working order is 222,000 lb. of which 121,000 lb. is on the 72 in. driving wheels. The cylinders are 22 in. by 26 in., and the rated tractive force 26,740 lb. The rigid wheel base is 13 ft. 2 in. and the total wheel base 39 ft. The boiler is 66 in. in diameter, 15 ft. 4 in. between tube plates, carries 180 lb. steam pressure and has a grate area of 30 sq. ft. The evaporative heating surface is 1730 sq. ft., of which 156 sq. ft. is in the firebox and 1574 sq. ft. in the tubes and flues. The superheating surface is 255 sq. ft. The tank holds 2,400 gal. of water and 3½ tons of coal.

Types of Freight Locomotives Ordered in 1922

THE possibilities for high tractive force combined with ample boiler capacity have made the Mikado or 2-8-2 type practically the standard main line freight locomotive on American railways. During 1922 orders were placed by American and Canadian roads for 1,573 freight locomotives. Of these, 1,231, or 78 per cent, were of the 2-8-2 type, 73 of the 2-8-0 type, 157 of the 2-10-2 type, and 104 of the 2-10-0 type. This list does not include locomotives of the 4-6-0, 4-6-2, or 4-8-2 types, which were designed to be employed in either passenger or fast freight traffic. Neither does it include 116 Mallet locomotives, some of which were for hump yard and pusher service and others for road service on heavy grades.

An idea of the size of the Mikado locomotives which are now being purchased can be obtained by reference to Table 1 which covers 1,200 locomotives of this type which were ordered in 1922. The list is arranged according to weight and is complete except for a few orders for one or two locomotives and a few small roads which ordered light locomotives of this type.

Grouped according to weight this list can be totaled up as follows:

Heavy (320,000 lb. or over) 587 locomotives, or 49 per cent.

Medium (300,000 lb. to 320,000 lb.) 291 locomotives, or 24 per cent.

Light (under 300,000 lb.) 322 locomotives, or 27 per cent.

While the Mikado is the most common type of freight locomotive, several roads which handle a large amount of drag freight find the 2-8-0 type a satisfactory locomotive. The principal roads which ordered this type were the Western Maryland, Philadelphia & Reading, Lehigh & New England, Norfolk Southern, and Toledo, St. Louis & Western. A summary of all locomotives of the 2-8-0 type ordered in 1922 is given in Table II.

The Pennsylvania Railroad which handles a large amount of low grade freight and which also has somewhat heavier grades than most other eastern trunk lines is unique in the extensive use of 2-10-0 type locomotives, of which 100 were ordered in 1922 and for which large additional orders have since been placed. These locomotives weigh 371,800 lb. in working order and have a rated tractive force of 87,000 lb. The only other order for locomotives of this type was one given by the Gulf, Mobile & Northern for four engines weighing only 202,500 lb.

A number of the western roads, notably the Union Pacific; Atchison, Topeka & Santa Fe; Chicago, Burlington & Quincy; Colorado & Southern; Illinois Central and Oregon-Washington Railroad & Navigation Company, ordered 2-10-2 type locomotives for use on certain divisions. The weight and size of the cylinders of the 2-10-2 locomotives ordered in 1922 are given in Table III.

Eight roads ordered a total of 116 Mallet locomotives in 1922. Of these, 30 for the Norfolk & Western, 10 for the Denver & Rio Grande Western, and 4 for the Northern Pacific, were of the 2-8-8-2 type with 25 in. and 39 in. by 32 in. cylinders and weighing 531,000 lb. The Denver & Rio Grande Western ordered also five narrow gage locomotives of the 2-8-8-2 type weighing 230,000 lb. Fifteen locomotives of the 2-8-8-2 type with 26 in. and 41 in. by 32 in. cylinders and weighing 494,500 lb. were ordered, 10 for the Union Pacific, 3 for the Oregon-Washington Railroad & Navigation Company, and 2 for the Oregon Short Line. The Chesapeake & Ohio ordered 25 of the 2-6-6-2 type with 23 in. and 35 in. by 32 in. cylinders and weighing 441,000 lb., also 25 additional, probably of the same design, while the Boston & Maine ordered two of the 0-8-8-0 type with 26 in. and 40 in. by 28 in. cylinders and weighing 441,000 lb. for switching service.

Orders placed by the United States Railroad Administration included 244 heavy 2-8-2 type locomotives weighing 325,000 lb. and having 60,000 lb. tractive force, 625 light 2-8-2 type locomotives weighing 290,800 lb. and having 54,600 lb. tractive force, 195 heavy 2-10-2 type locomotives weighing 380,000 lb. and having 74,000 lb. tractive force, and 112 light 2-10-2 type locomotives weighing 352,000 lb. having 69,400 lb. tractive force. It will be noted that 74 per cent of these locomotives were of the 2-8-2 type and 26 per cent of the 2-10-2 type. Of the 2-8-2 type 28 per cent were of the heavy and 72 per cent of the light type. Taken together the average weight of these Mikado locomotives was 300,000 lb. and the average tractive force 56,000 lb.

In addition the United States Railroad Administration ordered 30 Mallet locomotives of the 2-6-6-2 type weighing 448,000 lb., and 106 of the 2-8-8-2 type weighing 531,000 lb.

Comparing the orders given by the U. S. R. A. and those by the railroads in 1922, there is apparently a tendency to even greater employment of the 2-8-2 type and also a strongly marked tendency in the direction of increased weight and tractive force.

TABLE I—PRINCIPAL ORDERS FOR 2-8-2 LOCOMOTIVES IN 1922

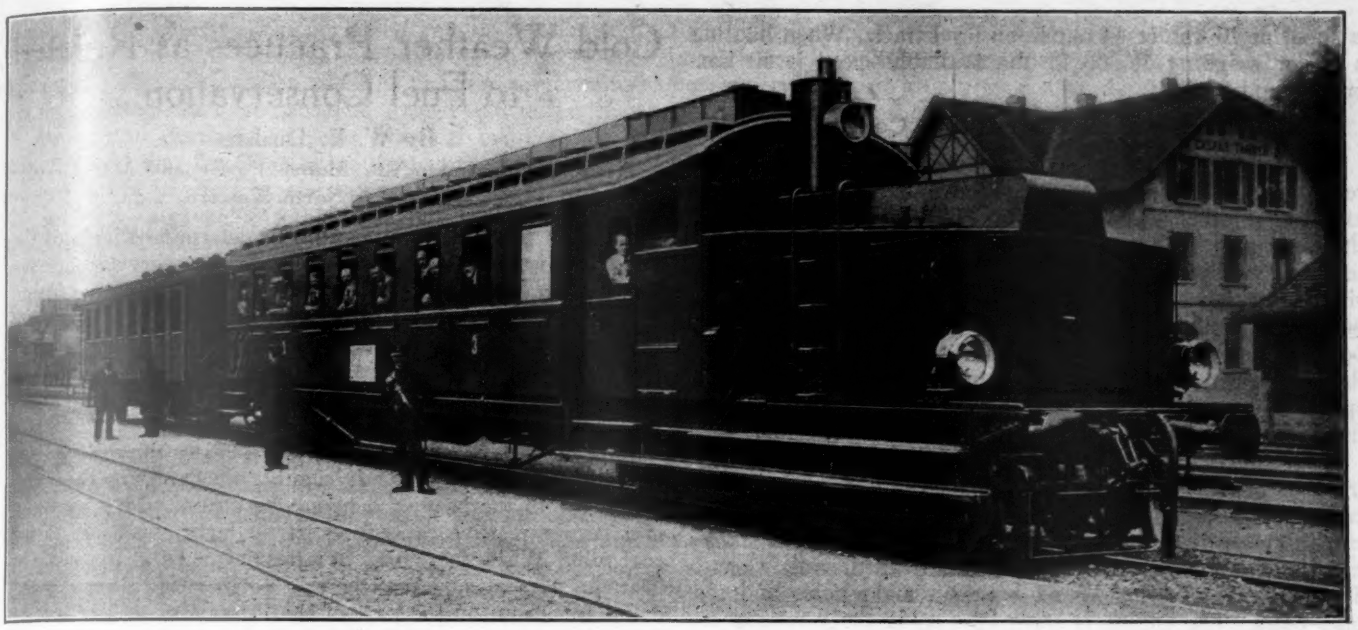
Road	No.	Weight, lb.	Cylinders, in.
Delaware, Lackawanna & Western	40	356,500	28 by 32
Central of New Jersey	10	342,500	27 by 32
Lehigh Valley	5	339,000	27 by 32
Northern Pacific	25	337,000	28 by 30
Fort Worth & Denver City	2	334,500	28 by 32
New York Central	122	334,000	28 by 30
Boston & Albany	8	334,000	28 by 30
Clev., Cinc., Chicago & St. Louis	50	334,000	28 by 30
Michigan Central	11	334,000	28 by 30
Lehigh Valley	10	333,000	27 by 32
Chicago, Rock Island & Pacific	30	332,000	28 by 30
Lehigh Valley	5	328,500	27 by 30
Fort Worth & Denver City	3	327,680	28 by 32
Baltimore & Ohio	85	327,400	26 by 32
Atchison, Topeka & Santa Fe	15	327,000	27 by 32
Missouri Pacific	46	327,000	27 by 32
Lehigh Valley	5	325,000	27 by 32
St. Louis-San Francisco	35	325,000	27 by 32
Erie	40	320,600	28 by 32
Lehigh Valley	10	320,000	27 by 30
Louisville & Nashville	30	320,000	27 by 32
Canadian National	45	315,000	27 by 30
Western Pacific	6	315,000	28 by 30
Missouri, Kansas & Texas	40	315,000	28 by 30
Montour	4	313,000	27 by 32
Chicago & North Western	78	312,000	27 by 32
Chicago & Eastern Illinois	10	310,000	28 by 30
New York, Chicago & St. Louis	15	307,000	26 by 30
Chicago, Burlington & Quincy	60	306,000	27 by 30
Grand Trunk	8	300,000	26 by 30
Duluth & Iron Range	3	300,000	27 by 30
Chicago, Burlington & Quincy	22	299,810	27 by 30
Seaboard Air Line	1	298,000	26 by 30
Georgia Railroad	5	292,000	26 by 30
Louisville & Nashville	22	292,000	26 by 30
Mobile & Ohio	10	292,000	26 by 30
Chicago, Indianapolis & Louisville	4	290,000	27 by 30
Nash., Chat. & St. Louis	12	290,000	26 by 30
Alabama Great Southern	10	288,000	26 by 30
Southern	15	288,000	26 by 30
Cinc., N. O. & Tex. Pac	25	288,000	26 by 30
Chicago, Milwaukee & St. Paul	100	287,000	26 by 30
Central of Georgia	10	286,000	27 by 30
Illinois Central	100	282,700	27 by 30
Central of Georgia	8	280,000	27 by 30

TABLE II—ORDERS FOR 2-8-0 TYPE LOCOMOTIVES IN 1922

Road	No.	Weight, lb.	Cylinders, in.
Delaware & Hudson	1	312,000	32½ and 41 by 30
Lehigh & New England	7	301,500	27 by 32
Western Maryland	10	294,900	27 by 32
Philadelphia & Reading	25	285,000	25 by 32
Detroit & Toledo Shore Line	3	214,000	23 by 30
Tennessee Coal, Iron & R. R.	2	209,000	23 by 28
Toledo, St. Louis & Western	5	201,000	22 by 28
Toledo Terminal	2	200,000	22 by 28
Green Bay & Western	2	199,000	22 by 28
Magma Arizona	1	199,000	22 by 28
Norfolk & Southern	5	191,430	22 by 28

TABLE III—ORDERS FOR 2-10-2 TYPE LOCOMOTIVES IN 1922

Road	No.	Weight, lb.	Cylinders, in.
Atchison, Topeka & Santa Fe	6	407,000	30 by 32
	20	396,500	30 by 32
Colorado & Southern	1	405,710	30 by 32
	1	400,810	30 by 32
	3	397,170	30 by 32
Chicago, Burlington & Quincy	10	397,000	30 by 32
Illinois Central	25	382,000	30 by 32
Utah	1	375,200	29½ by 30
Union Pacific	73	370,200	29½ by 30
Oregon-Washington R. R. & Nav	15	370,200	29½ by 30
Alabama & Vicksburg	2	270,000	26 by 28



Swiss Diesel-Electric Motor Car with Trailer

Sulzer Diesel-Electric Rail Motor Car

Car With 200-hp. Diesel Engine Seats 69 Passengers and Shows Low Fuel Consumption on Swiss Railways

FOLLOWING the experiments with a direct-driven Diesel locomotive on the Prussian State Railways in 1913 orders were placed with Sulzer Brothers, Winterthur, Switzerland, for five self-propelled rail cars to be driven by Diesel engines coupled to electric generators with electric motors geared to the driving axles. Three of these cars were for use on the Prussian railways and two on the Saxon railways. Two of the cars were delivered and operated satisfactorily before the outbreak of the war, but since that time conditions have been such that no further development was undertaken until recently.

In taking up the work again the manufacturers, Sulzer Brothers, decided to take back the cars and equip them with engines of a new and improved type together with new electrical apparatus that had been perfected by Brown-Boveri of Baden. It is one of these rebuilt cars, now being tested out on the Swiss Federal Railways, that is shown in the illustration.

General Description of the Cars

The car is of standard gage and approximately 70 ft. long over buffers. There is an engine compartment at one end and operating platforms at both ends, the car being so equipped that it can be driven with equal convenience in either direction. Seats are provided for 69 third-class passengers with standing room for 16 more. Entrance and exit is made at either end through the roomy driving platforms which are separated from the body of the car by sliding doors.

The light weight of the car is 146,600 lb., 85,200 lb. being on the six-wheel truck on the engine end and 61,400 lb. on the four-wheel truck on the motor end. These weights correspond to an axle load of 28,400 lb. on the engine end and 30,700 lb. on the motor end.

The driving power is obtained from a six-cylinder, four-cycle Diesel engine of the Sulzer "R V" type which is connected to a direct-current generator through a flexible coupling. The fuel is injected directly into the cylinders through the injection valves without the employment of injection air, the necessary pressure being furnished by combustion of a part of the fuel itself. By the adoption of electric starting, obtained by a suitable winding of the generator and by the installation of storage batteries, air compressors with complicated valves and control mechanism which were used on the original installation have been dispensed with and the general design considerably simplified.

The three pairs of cylinders are arranged in a V form, each pair of pistons being connected to a common pin of the three-throw crank axle. The crank case is enclosed and provided with inspection covers while the cam shaft is parallel to the crank axle. The engine when running at 440 r.p.m. develops 200 hp. and is capable of delivering 250 hp. for a short time. It is designed to be run at a constant speed regardless of the speed of the car. The governor and feed pumps are placed in front of the engine, the control being such that each cylinder may be cut out automatically from the driving cab or controlled by the governor in the usual manner.

The exhaust muffler and the air inlet manifold are placed between the cylinders with the fuel tank above them. The capacity of the tank is 350 liters (92½ gal.) which is sufficient for a run of 50 km. (314 miles) under average conditions.

The cooling water after leaving the cylinders passes to a series of ribbed coolers on the car roof. These are so grouped in combination with the water reservoir that by cutting units in or out the desired temperature can be maintained regardless of weather conditions and temperatures.

Vibration is avoided by mounting the engine and generator on a special frame which is not connected to the body of the car but is carried directly on the truck frame through spring connections. The weight of the front end of the car is carried by a spherical pivot which acts as a center pin and rests on a modified truck bolster.

The capacity of the engine is sufficient to drive the car at

a speed of 70 km. or 44 m.p.h. on level track. When hauling a trailer weighing 66,000 lb. the available speed is 60 km. or 37 m.p.h.

Electrical Equipment and Control

The main generator is separately excited, the exciting current being furnished by a special dynamo mounted on an extension of the generator shaft. The main generator is of the eight-pole type and has a capacity of 140 kw. with a terminal voltage of 300 while the exciting dynamo is of the six-pole type with an output of 7.5 kw. The accumulator battery feeds the field windings of the exciter. The circuit between the generator and the motors is so arranged that the engine can be run at a constant speed regardless of the speed of the car. This insures easy starting, full control of the speed of the car and economy in fuel consumption.

Two direct-current motors are mounted on the four-wheel truck on the rear end of the car. They are fitted in a common cast steel casing and both are geared to a crank shaft which carries crank discs, connecting rods being employed to transmit the power from the crank discs to the driving wheels. The motors are series wound with six main poles and six inter-poles. The engine is started by using the generator as a motor operated by current from the storage battery underneath the car. Direction switches and controllers are provided on either platform. The controller handle is of the dead-man type and if not held down the current is shut off and the brakes applied. A time relay with a retarding cylinder holds back the application of the brakes until five seconds have elapsed from the time the current is cut off.

The brakes are of the Westinghouse type, the compressed air being supplied by a small air compressor driven by the engine. In emergency applications, the current is automatically cut off. Hand brakes are also provided.

Operating Results

On a somewhat hilly road between Wallisellen, Winterthur and Romanshorn with the car alone without a trailer, the fuel consumption was 84 kilos or 185 lb. for the round trip of 92 miles, which is equivalent to 0.03 lb. of fuel per ton-mile. The load was subject to frequent variations and the engine was shut down on the longer grades, being in operation only about two-thirds of the time.

Records covering a month's service on the Baden, Wettingen and Niederglatt run showed an average fuel consumption of 0.043 lb. per ton-mile. The consumption was at the rate of 0.047 lb. per ton-mile at first but fell to 0.040 lb., probably due to the longer experience and increased skill of the driver. In these records the fuel used for switching, recharging storage batteries, etc., was included while the mileage was taken as that in regular service.

This car has attracted considerable attention in Switzerland and as a result a second car will shortly be placed in service on the Berne-Neuchatel section of the Lotschberg railway. Not only has the fuel consumption been remarkably low but the small stand-by losses and the short time required for attention at terminals have shown that a car of this type possesses decided advantages over steam operation. Fifteen minutes is sufficient to start the engine, charge the air brake system and have the car ready to start. Even less time is required to shut down and leave everything in order.

The car is of moderate power but its range is considerable and its size is much larger than most of the gasoline rail motor cars used in the United States. It is hoped that further experience will lead to the construction of large units which will result in a Diesel locomotive.

"Stop That Leak" is the slogan of a campaign which has been started in the Baltimore & Ohio Employees' Magazine to reduce expenses. Officers in all departments are pointing out opportunities for economies in their various fields, and employees are being urged to contribute suggestions.

Cold Weather Practices as Related to Fuel Conservation*

By W. E. Dunham
Assistant Superintendent, Motive Power and Machinery, Chicago & North Western

As it is practically impossible to determine which of the cold weather problems of the fuel supervisor are the most important or affect the consumption of locomotive fuel to the greatest degree, we will not attempt to take them up in any logical order. It is assumed that winter problems refer to the situations that exist in the northern or colder district where the weather creates a real problem.

In the past we have often heard the remark that with the coming of cold weather we must sharpen up the draft of the locomotive so as to make it capable of handling the extra drain due to the heavier demand for steam. This certainly is a very expensive procedure, particularly expensive to the coal pile. While there may be a heavier demand for steam to heat the passenger trains, there is no materially heavier demand for steam on the part of the locomotive to perform its full quota of work. Following such a practice is almost an admission that the engine has not been drafted properly during the warmer season of the year to most economically consume the fuel furnished. To some this may sound like rather strong language, but to others who have established a close check and supervision of the adjustment of front ends and size of nozzle tips, it will simply confirm the fact which they have already developed.

Instead of the problem being one for the winter months, the adjustment of front ends is a matter of all the year round and when once established should not be altered as has unfortunately been the practice for the changes in the seasons. This, of course, assumes that the fuel is the same in all seasons. It goes without any question that a change of fuel requires a change in drafting, particularly in the size of the nozzle tip, to get the most economical results on the locomotives.

There is the old problem in the heating of passenger trains that is new every winter. While we have been at it year after year, there is still a lot to do to get the heating of these trains down to the point where it is economically and regularly accomplished. The old style straight steam system where the train crew regulates the supply of steam and the drip for each car separately is still in use. With the profligate waste of steam in the front cars of the train, the rear cars of some of the longer trains are usually cold, even though the pressure at the regulator in the locomotive cab is sufficient to blow the hose off. A simple expedient that has corrected this difficulty to a very large degree when tried is to place a plug nipple in the steam line of each car behind the control valve, in which a small hole is drilled of sufficient size to deliver all the steam that can be properly used in heating the radiation that the valve controls. Such an arrangement "educates" the trainman very satisfactorily and saves many pounds of steam and coal.

While speaking of the heating of passenger trains we must not overlook the train line, all the way from the engine cab to the rear of the train. In some cases even now, there is only a very meager covering placed around this 1½-in. or 2-in. pipe to prevent wasteful radiation to the atmosphere. Here is a pipe line that at freezing temperature and with the train standing still, will waste coal at the rate of fully one ton per year for about each two square feet of surface which is close to two feet of length. What that waste will be with the train moving 40 miles an hour through the cold air can readily be imagined. These pipes should be covered with the best obtainable covering and also be protected in such a substantial

*From a paper presented at the meeting of the Chicago District Chapter of the International Railway Fuel Association, March 12, 1923.

manner that the covering will not deteriorate or be damaged.

The subject of pipe covering naturally leads us to the engine cab. The many steam pipes to the pumps, generator turbines, injectors, etc., are causes of wasted coal unless they are covered and insulated in some practical manner. It is sometimes said that the expense required to prevent excessive radiation is not justified by the saving in coal that will result. In some cases such as this, that may be true from the dollars and cents balance. On the other hand, the influence on the engine crew and other employees in seeing that the railway company is in dead earnest in this fuel economy campaign and covers even the small steam pipes that would waste coal, is a mighty factor in getting the desired economy at the scoop and elsewhere.

With the modern hopper bottom ash pan, the cold weather brings up a serious situation at the clinker pit. A makeshift arrangement used at many terminals to thaw out the frozen pan, is an open grate fire that is kept burning all the time at the approach end of the pit. This does the business, but at a fearful cost of coal. A more economical plan and one that is now being tried out successfully is to use an oil torch that can be fired up as required and which can be played on the hopper of the pan and even on the sides as well.

It is here at the cinder pits that we find a great waste of fuel when a congestion develops as the result of not being able to handle the engines promptly over the pit and into the house. Fuel men and their assistants must necessarily watch the cinder pit every hour of the day and night during the winter months. When that place ceases to function regularly and promptly there is trouble ahead for everyone and a large amount of additional coal is burned in keeping engines alive, waiting their turn to be handled.

While we are on the subject of cinder pits, the next thought is naturally turned to the general situation of the approach and departure tracks to the enginehouse and the arrangement of the facilities for supplying the engines with coal, water, and sand. Every engine arriving at the terminal should be able to promptly reach the track assigned for the crew to leave it, then as quickly be furnished with the necessary supplies, have the fire cleaned and be placed in the house or turned for use as may be required. That, of course, is the ideal condition and every detail of the equipment furnished to accomplish that result should function correctly.

Even with the best facilities provided for prompt handling of engines at the terminal, close supervision is necessary to see that engines are left by the crews in proper shape to stand the extreme changes in condition between hauling a train on the road and standing practically still at the terminal. The fires must be left in good condition and the boiler should be full of hot water with the steam close to the working pressure. A last minute building up of the fire and filling up of the boiler is disastrous, to the boiler and flues and that means extra coal burned at the time as well as during the remaining life of the flues, provided they are not in such shape that they can be re-worked. Even if they can be re-worked the loss of heat and fuel in cooling the boiler down so that the boilermaker can do his work properly is great.

The housing, or rather the lack of housing of engines, is possibly the greatest single problem of the fuel man. Without discussing the subject of the distribution of the expense for the extra fuel required to keep engines from freezing due to not being protected from the weather, such a condition uses up tons of fuel uselessly. If the locomotive could, on the other hand, be protected from the direct action of the weather this waste could all be saved. Enginehouses where the doors cannot be closed securely behind the tenders of the longer power, houses with doors so poorly designed and constructed that they leave large openings for the weather to keep the temperature of the house the same as out of doors, houses with poor and insufficient heating equipment all mean wasted fuel. The improper maintaining and operating of the inadequate housing facilities that are provided are matters that the fuel supervisor must keep after constantly and have remedied when defective and slack before they become serious. Simple and inexpensive vestibuling of a few stalls will permit doors to be closed, the tacking of canvas strips over the openings around the doors at the hinge edge and the securing of canvas or heavy roofing paper flaps over the other edges of the doors are expedients that can be used to good advantage and save a lot of this wasted fuel.

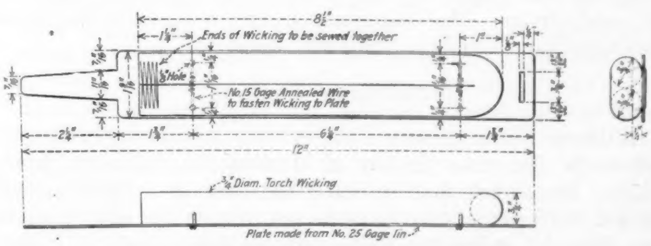
Where engines are necessarily required to stand out of doors during the layover, there is, of course, a very heavy and wasteful use of fuel. This can be decreased very materially all the year round, but especially so during the winter months by the simple expedient of covering the stack to prevent undue consumption of the fuel. Covers in which an opening is provided of just sufficient size to maintain a good fire on the grates conserve the heat that is generated and in that way lessen the demand for forcing of the fire. When about 4,400 tons of coal are burned on one road in a month's time keeping engines alive out of doors it is quite evident that the fuel supervisor has something to do in everlastingly keeping alive the subject of engine housing.

Piston Rod Swab for Air Compressors

By E. A. Miller

THE majority of swabs used on the piston rods of air compressors give trouble either because they do not have effective arrangements for holding them in place, or because the metal parts soon come in contact with the rods. The design shown in the drawing is intended to overcome both these difficulties and has proved very satisfactory in service. It is easily made because it consists merely of a flat plate to which torch wicking is fastened.

The plate is made, as shown, of 25 gage tin with a tapered projection, 2¼ in. long at one end and a ⅛-in. by ¾-in. slot at the opposite end. A piece of ¾-in. torch wicking, 16 in. long, bent double, with the ends well sewn together, is



A Simple and Effective Piston Rod Swab

fastened to the plate in two places by 15 gage annealed wire passing through ⅛-in. holes. It will be noted that the fastening wires do not come near the surface of the wicking which is in contact with the rod, so that it can be worn considerably before the swab will need to be replaced. In applying the swab to the compressor the wicking is placed next to the rod and the swab is bent and turned back, thus securely holding it in place. One such swab is used on 9½-in. compressors and three on 8½-in. cross-compound compressors.

In Arkansas a bill has been introduced in the lower house of the general assembly which provides that whenever a passenger train is one hour late a special train must be run on its schedule, except when the lateness is excusable because of the wreck. Failure to observe the proposed law would be punished with a fine of $1,000 for each offense.

As to the Locomotive—What Next?*

Co-ordination with Other Facilities; Harmonizing Features of Design, 2-8-4 Wheel Arrangement Proposed

By G. M. Basford

Consulting Engineer, Lima Locomotive Works

ACCEPTANCE of the locomotive as the most promising single factor for reduction of the cost of transportation is proceeding rapidly. It has not always been looked upon as a possible cost reducer. There are reasons. Consider locomotive history which divides into three eras.

First: The beginning of steam rail transportation. We must admire those who pioneered without precedent, giving us elements, principles and even construction that endured for a half century without radical engineering changes.

Second: The period of increasing weight and power with practically no persisting improvements making for higher efficiency in fuel or in weight. During this time locomotives were crude pullers of trains. Too many unmodernized locomotives are just that today.

Third: The era for reducing ton-mile-per-hour costs by means of improved locomotives. It is the era for co-ordination of the locomotive into the rapidly developing scheme of efficient railway operation. Engineers inside and outside the railways and railway officers, executive and operating, are beginning to co-operate. Never before in locomotive history have six railroads simultaneously striven for better locomotives to reduce their cost of transportation as six roads are striving today.

Many operating officers do not yet realize how much the improved locomotive can help them. They do not yet realize how much help they need from the improved locomotive. Through a natural development these officers control the expenditures. They are the ones, in general, who decide questions of investment in improved locomotives and in all facilities that render the locomotive more productive. Because of tradition the steam locomotive is handicapped today as to its productivity. Operating officers are in position to remove this handicap. We must tell them about it.

Locomotive Earnings

William Elmer throws light on this subject in his paper before the American Society of Mechanical Engineers, June, 1921. He shows that in 1920 the average freight engine earned $370 per day or 26 cents per minute but that it made less than 60 miles per day. On another occasion (before the Central Railway Club in January, 1923) Mr. Elmer shows that for the month of October, 1922, the average daily mileage of serviceable freight locomotives was 84 miles. Are we to be satisfied with these figures? A locomotive is too expensive to be running only 7 hours out of 24 hours.

For a $47,000 Mikado engine the fixed charges are $14.40 per day or one cent per minute. It would be good business policy as far as fixed charges are concerned greatly to increase the first cost of the locomotive if a small percentage of the fuel may be saved thereby. Locomotive loading is so important as to cause a loss of $100 per day with an error of 10 per cent in overloading or underloading on a single division having heavy traffic. This reveals the importance of the operating side of the question we are trying to answer, as the locomotive referred to burns from $10 to $15 worth of fuel per hour and wages amount to about $4 per hour.

As to the use made of locomotives are we to be satisfied when they are approximately but half the time in the hands of the operating officers and the other half in the hands of mechanical officers? Of course, there is a lot of avoidable delay in each case. Here is an opportunity for co-ordination of loading, using and maintaining not to be overlooked.

Co-ordination of two kinds lies before us. First, the locomotive must be harmoniously co-ordinated as a vital element into the great transportation machine. It must fit and perform in time and in tune with physical and operating improvements which are coming forward with great rapidity and promise. Second, the locomotive must be co-ordinated within itself. Every feature of design must be made to harmonize with every other for the production of more ton-miles-per-dollar of total cost.

Our locomotive is a machine within a greater machine. This demands of locomotive men a thorough understanding of track, operation and signaling. It demands of operating men, track, bridge, terminal and signal men a thorough understanding of the locomotive which must be considered as a huge investment capable of producing dividends greater than it has ever produced. It demands of engineers who would improve the locomotive a careful study of all phases.

Recently an Eastern road invested $14,000,000 in a new line to reduce a heavy grade. It is up to the locomotive to increase the return on this investment. In railroad operation there are few features of improvement that do not call for corresponding improvement in the locomotive. These items require more elaboration than space and time permit of giving here. A mere list, however, reveals the problem.

Those days are gone when old road engines would do for switching. Switch engines call for most careful design, that they may make every track of a yard more productive. Road engines coupling to heavy trains at yards must be equipped for rapid acceleration to clear the outgoing track quickly for following trains.

Engine Terminals

Locomotive terminals would justify a chapter by itself. Many a locomotive terminal limits the productivity of the locomotive power of its road today. Every improvement in this field calls for a corresponding improvement in the locomotive to take full advantage of the investment. Think of ash pits, inspection pits, coaling stations, roundhouse and roundhouse shop facilities. These are coming forward rapidly. Soon every roundhouse will have traveling cranes, post cranes, drop pits, means for handling parts too heavy for archaic, man-killing methods, means for washing boilers quickly with hot water so that boilers need not be damaged by washing and filling with cold water. It is a six to ten hour job gradually to cool a boiler down. Improvements are also ready for rapid firing up of boilers, for saving time and labor in dealing with ashes, sand and coal. Again, shop equipment is receiving more attention than has been given to it for many years. But our railroad shops are many years behind the requirements. Every order for new locomotives should be accompanied by a corresponding program for more machinery and facilities for maintenance.

Long Locomotive Runs

Formerly locomotives were designed and built for short railroads, then for divisions because the roads grew that

*Abstract of a paper presented before the Pacific Railway Club, March 8, 1923.

way. Now they must make long continuous runs. The Southern Pacific was a leader in this change. The Santa Fe is also a leader. The Missouri, Kansas & Texas has broken all long run records. But we must build engines that will more nearly approximate the continuous service of marine engines and this can be done. One road does with 16 engines work formerly requiring 21, by increasing the run from 150 to 260 miles. Oil fuel overcomes one of the greatest obstacles to long continuous runs. The locomotive must be co-ordinated with this operating improvement and coal burners must be made to do it. Great savings are being effected by longer locomotive runs. This is one of the most important operating improvements of our day. It calls for co-ordination in locomotive design, construction and maintenance and adequate facilities for maintenance.

Up to the Locomotive

What must the locomotive be and what must it do to earn most for these large investments? What must it do to overcome high wage and fuel costs? The next new locomotives must be built, operated and maintained to perform a new part in the reduction of the cost of transportation. Placing new locomotives on our rails for say 30 years of service is a matter to be approached thoughtfully. If we are to save the race against government ownership we must regard the locomotive in a new light. All the new ones must be built and bought for efficiency, for maximum earnings on the investment. It must have appropriate maintenance.

This era began with plain engines. Modern locomotives are efficient and necessarily complex power plants. Between these two there is a vast difference. Improvements were developed independently, usually not by the builders but by independent companies, each devoting its efforts to its particular problem. This has brought highly developed individual factors for increasing capacity or improving efficiency. In the combination of these factors with improved detail design, co-ordinating the locomotive into a truly efficient power plant, lies our present problem. Weight questions now predominate. The locomotive must be designed as a whole. It must not be condemned to run for life without certain efficiency factors because weight limits do not permit of applying them. Because of weight limits locomotives are being built today without boosters, stokers and feed water heaters. These particular engines cannot even be built for later application of these efficiency factors and must run wastefully for the next 20 or 30 years. But truly co-ordinated designs will permit of obtaining the savings these factors are ready to effect.

Superheaters

The further progress of superheater design must necessarily be along the lines of more boiler and more superheater capacity per square foot of tube area available. Obviously, boiler sizes cannot continue to increase, and if we are to build larger capacity locomotives we must make them more economical in steam consumption, or produce more power from a given boiler size, or both. This is the aim of the type E superheater. In the selection of a superheater consideration also must be given to cost, weight and maintenance. The type E superheater is more expensive in first cost than the type A and can only be justified where the demands upon the boiler thus fitted warrant its installation. An important development in superheating lies in placing the throttle in such position as to provide superheated steam for the auxiliaries.

Thermic Syphon

The thermic syphon supplies two greatly needed features: First, increased absorption surface in the firebox for radiant heat; second, improved circulation at the place where it is needed most, at the hottest part. This factor adds weight, but every pound of weight is where it will do the most good. Efforts to provide re-entering radiant heating surface from firebox sheets have been made but never before has the maintenance problem been solved in this connection. No new locomotive should be built without this improvement or its equivalent, if you can find its equivalent.

Feed Water Heaters

Feed water heaters are coming forward rapidly. They catch and return to the boiler a proportion of the heat that is on its way to waste. They also reclaim about 15 per cent of the water used. They compel the exhaust steam to help the boiler and the firebox. Incidentally, the feed water heater is a good example of the necessity for co-ordination. It calls for design and development in unison with the superheater and other factors. No locomotive should be built without this conservation feature. Locomotive people in the past have not felt the need of it, but they need it now. They need it for increased capacity, for fuel conservation and for elimination of water stops. Closed heaters and open heaters are now operating on locomotives with success.

Mechanical Stokers

Mechanical stokers remove the limitations to the amount of coal that can be put on the grates of a locomotive. They provide means for getting more horsepower into the firebox, more than the best and strongest of firemen can throw through the firedoor. Mechanical stokers have made the big, powerful coal-burning locomotive possible. In relieving us of one limitation they have introduced another, that of burning the coal that they can supply.

Improved Valve Motion

Improved valve motions have contributed to increased capacity. They have emphasized the importance of steam distribution, of valve setting and of valve motion maintenance. They have helped the boiler materially and have contributed their quota toward developing locomotive practice along the lines of economy and certainty of operation. Look at the article in the *Railway Mechanical Engineer*, June, 1922, page 315, to see how one road saved twenty dollars per trip by correcting valve setting. This indicates the value of another phase of co-ordination.

Power Reverse Gears

Power reverse gears have done their part. Cut-off adjustment is most important in securing maximum cylinder power without waste of steam. It is absolutely impossible to obtain and maintain correct adjustment by hand with varying demands for power because locomotives have become too big for hand adjustment. Efforts are being made to secure the right cut-off adjustment automatically, an important thing to do. Cut-off adjustment merits infinitely more attention than it is receiving. By incorrect cut-off adjustment it is easy to lose 10 or 15 per cent saving that some efficiency factor has made. Locomotive engineers need to be shown just what cut-off to use for every speed. Bright minds have already worked out this part of our co-ordination problem.

Water Purification

Boiler water treatment and facilities for quick washing of boilers contribute their part. Some years ago the speaker rode on an engine that could not blow its whistle because of the character of the water used. Think of what such water did to the firebox sheets and flues and the cost of this handicap. Water treatment and boiler washing equipment help the firebox. Money invested in improving boiler water supply is sure to yield large returns. Do not expect a boiler to work against the handicap of boiler scale, one of the most effective heat insulators known.

Steam Separators

Knowing as we do that the locomotive boiler is forced and that forcing carries much solid water over into the superheater, we must extend the use of so-called steam separators

to relieve the superheater of double duty. It is enough to ask the superheater to superheat steam. Whatever we do to increase the activity of the firebox and its circulation increases the importance of keeping the water back in the boiler. Steam separators are working satisfactorily. What are you doing about this?

Alloy Steel Parts

Beginning in 1884, the application of the principle of lightening reciprocating and revolving weights in this country has certainly been deliberate. This improvement is coming forward rapidly. During the past year 20 railroads have built over 1,000 engines with reciprocating parts of alloy steel to the relief of not only the firebox, but of rails and bridges. Weight limitations have been rather arbitrary. Static weights are not the only weights to consider. Track officers are beginning to take dynamic augment into account and when these forces are considered, they co-operate for still more powerful locomotives. Simple alloy steels which do not require quenching and tempering remove the only obstacle to this greatly needed development. A saving of a blow of 3,224 lb. per side of an engine every time the drivers turn, in say 30 years, is not to be overlooked. Neither is a saving of 1,800 lb. in actual weight of moving parts to be ignored. What do you think of reciprocating parts of a big freight engine that weigh 2,600 lb.? I call it brutality, not engineering.

Fan Blast

No thoughtful person can fail to see that the method of producing draft by the blast of the exhaust jet is inefficient and wasteful. Its automatic adjustment of the draft to the demand for steam and its simplicity are the only justifications for its persistence. It soon must give place to something better. This has not yet been made completely successful, but it must be worked out to a conclusion. We pay too much in fuel for the draft of big engines today. Let us encourage efforts in this direction. I am informed that a test on a certain big Mikado engine showed a loss of over 800 hp. to blow the fire in the usual way.

Excessive Weight on Trailers an Important Problem

Trailing wheels were added to carry large fireboxes. They are needed for power at speeds when high boiler horsepower is demanded. The booster puts these wheels to work at low speeds, in starting and at critical points on grades and turns this loss to advantage at times when high boiler capacity is not needed. It helps the operating officer to increase tonnage, to increase acceleration to speeds. It is the means whereby a trailing wheel locomotive is placed in the class above itself as to tractive power. It avoids the necessity for another pair of drivers, needed in starting but superfluous when the train is rolling. The booster is a necessary improvement. It increases the weight of the back end of the engine and we must provide for this weight. It most certainly cannot be taken out of the firebox weight but must be taken care of in addition thereto. No locomotive with trailing wheels should be built without utilizing these wheels for traction in starting and on the critical points on grades.

Ash Pans

Long locomotive runs reveal weakness in this neglected item. Pans must be larger. They must have greater air openings in order to reduce the vacuum below the grates. A ratio of 14 per cent of the grate area is considered satisfactory if the rate of combustion is low enough, but with 14 per cent over one inch of vacuum has been measured in the ash pan. Why not make this area of opening 20 per cent of the grate area? Why not make openings as large as possible? We should supply at least 33 per cent excess air which means 16 lb. of air per pound of coal. Do you realize that at a combustion rate of 120 lb. of coal per square foot of grate per hour nearly one ton of air must be supplied every hour for every square foot of grate area? What locomotive gets that much? Do you realize that at 10 lb. of air per pound of coal and a consumption of 10,000 lb. of coal per hour the firebox will demand 1,300,000 cu. ft. of air, or 100,000 lb. per hour?

Grates and Grate Areas

Test plant records indicate that we are forcing fires to the point of inefficiency. Fig. 1 indicates a drop of 6 per cent

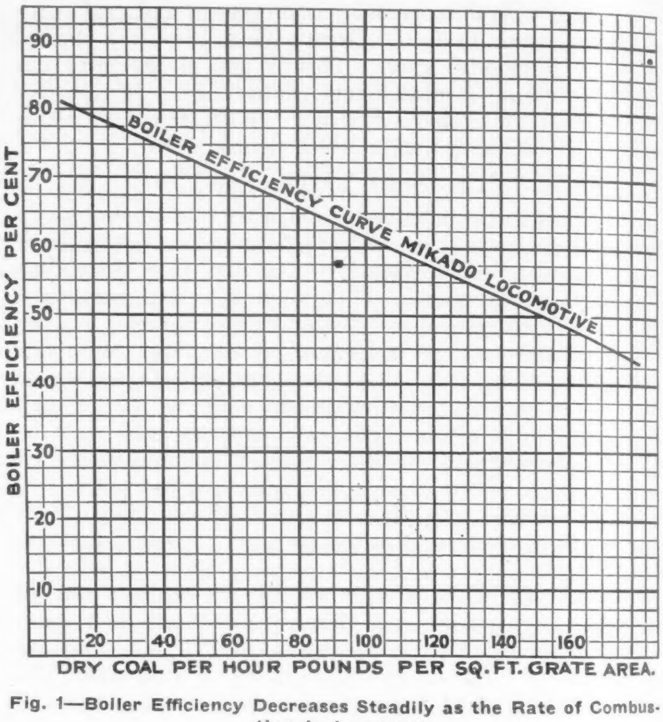


Fig. 1—Boiler Efficiency Decreases Steadily as the Rate of Combustion Is Increased

in boiler efficiency as the rate of combustion goes up from 110 lb. of coal per square foot grate per hour to 140 lb. Grates call for immediate intensive study. Why should the air openings through grates vary from 26 to 50 per cent in 62 cases of grate practice for soft coal engines recently studied? Differences in the character of coal do not explain this variety of figures. Who is in position to defend such chaotic practice?

Grate area affects losses in sparks and cinders. Run of mine coal with a large proportion of slack will make more sparks and cinders than lump coal, and what about lignite? This calls for lower velocity of air through grates. Velocities of gases through the firebox range from 100 to 300 ft. per sec., as fast as 200 miles per hour. We cannot wonder that this lifts sparks and cinders from the fuel bed. For years we have fired much more coal than has been burned.

Coal does not burn on the grates. The fire itself is mainly a gas producer. At the rate of 120 lb. of coal per square foot of grate per hour and 12.25 lb. of air supplied per pound of coal and with a high volatile coal (Westmoreland with 14,430 B. t. u. heat value per pound) 2,000 cu. ft. of gas is evolved every second. A firebox of 311 cu. ft. capacity is filled with gas six and a half times every second. This reveals the task we are asking fireboxes and boilers to perform. We must do our best to take as much of this heat as we can while it is in our hands. This calls for firebox volume and combustion space. These add weight. The job of the firebox is to absorb radiant heat. This discussion does not attempt to cover the absorption of the heat after it is created. It may be said, however, that progress in the direction of reducing the rate of combustion by providing larger grates helps in the next step—that of absorbing the radiant firebox heat. When grates are large enough it is easier to get the volume the firebox requires, but this again brings us face to face with the problem of weight.

Firebox designers are faced with the fact that the firebox evaporates about 40 per cent of the total. Firebox heating surface is from 5 to 10 per cent of the total heating surface but it effects from 25 to 50 per cent of the total evaporation.

Why is it necessary to fight for steam in a fairly well designed and proportioned coal burning firebox when that same firebox yields steam "to burn" when oil fuel is introduced? Oil burning temperatures that range about 2,500 deg. F. as compared with about 1,800 deg. F. for coal is the answer. Coal fire temperatures may be raised by forcing but with correspondingly increased spark and cinder losses. We must get greater volume of heat from coal.

In locomotive service oil has always been burned in fireboxes designed for coal. Oil leaves no ash, discharges no sparks or cinders and, if it has air enough and room enough, it burns completely. In many oil burning engines, however, the combustion space is too small and the action resembles a blowpipe flame. This puts tube and firebox sheets to a test that they would not encounter if more combustion space was provided. Why not design a real oil burning locomotive firebox, which the writer believes has never been done? Would it have a circular cross section and a long combustion chamber? To get the utmost out of oil, weight must be added at the back end. Therefore, the weight problem is common to oil and coal burning.

High rates of combustion brought the wide firebox. The wide firebox brought the trailing wheel. The stoker eliminated the limitation of the human hand, arm and back. Locomotive improvements that make for greater capacity, for efficiency and economy have delayed the next step but increasing demand for power has again brought a limit. Again it is the firebox. Not only must we provide weight for the larger grate and the locomotive furnace but we must have the booster and the stoker—all at the back end of the engine.

Threatening Limit to Locomotive Progress

While locomotives have been increasing materially in size in the last few years, certain limiting features have not been correspondingly increased. Locomotive designers have met this limitation by the addition of front truck and driving wheels to take care of the additional tractive power.

In conventional locomotive designs the firebox has been carried by one pair of wheels located underneath the grates. The wheel load of the trailer is, of course, subject to the same limitation of weight as the drivers. In practically all modern designs trailers have been loaded up to their limit. Weights as high as 60,000 or 63,000 lb. have been used. Most roads do not like to exceed 55,000 lb. and some confine the limits below that figure. It is evident that the size of firebox as related to the grate area and firebox heating surface is obviously limited by the allowable weight on the trailer axle.

In the search for means for increasing the power of the locomotive we have now come squarely up against this limitation of trailer weight. Greater and greater horsepower outputs are required which call for larger firebox volume and more grate area for burning the coal. With the present construction we are limited by the trailer wheel load mentioned above. The consequence of this has been that the size of grate area and fireboxes have not kept pace with the increase in cylinder horsepower output. An attempt has been made to make up for this by adding heating surface in other parts of the boiler which are not carried directly over the trailer, but this is only a partial remedy for the difficulty. The result is that the grate being limited as indicated, there has been a constant tendency to burn more and more coal upon a given area of grate or to increase the rate of combustion. In some modern designs the rate of combustion per square foot of grate to meet the maximum horsepower demands has gone as high as 130 lb. based upon first-class coal. In fact, the rate has gone much higher. It has been conceded that a rate of 120 lb. of coal per square foot of grate is a figure which should not be exceeded, and numerous tests indicate that if a lower rate could be secured increased boiler efficiency would result. To sum the matter up, further development and extension of locomotive power is dependent upon adequate methods of taking care of larger grate areas and firebox heating surfaces than present construction allows.

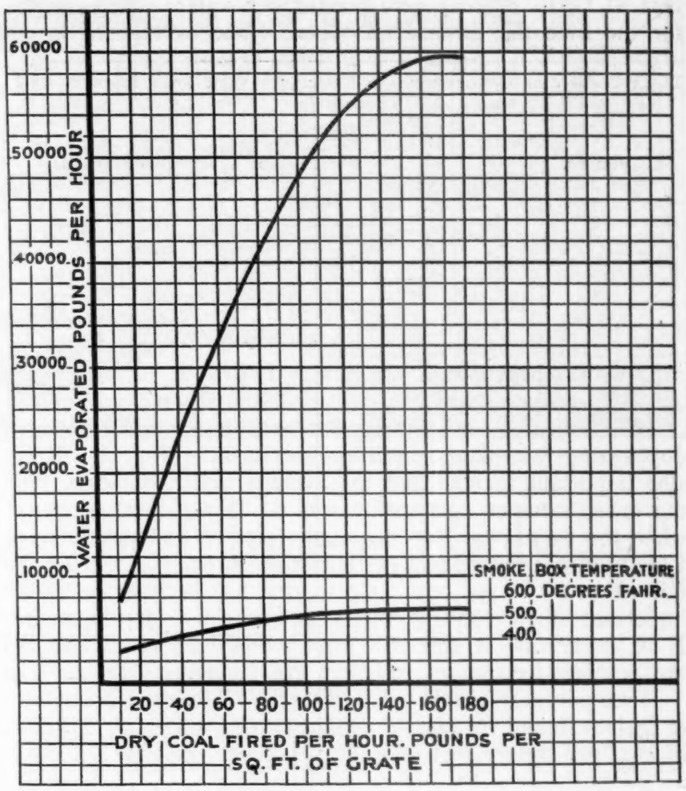


Fig. 2—Increasing the Rate of Firing Beyond the Capacity of the Firebox Does Not Give a Corresponding Increase in the Amount of Steam Generated

Fig. 2 gives a good idea of the influence of the rate of combustion upon locomotive performance. This curve shows total water evaporated plotted against dry coal fired per hour in pounds per square foot of grate for a Mikado type locomotive. There is a break in the curve after about 130 lb. per square foot of grate per hour is reached. That the performance of the boiler is not limited by the ability of the heating surface to absorb heat is shown by the smokebox temperature curve. There is no break in this smokebox temperature curve at the point where the evaporation begins to fall off. This conclusively shows that it is a combustion condition that causes the falling off in rate of evaporation.

Using Fig. 2 as an example, suppose that we have a locomotive designed to burn 120 lb. of coal per square foot of grate per hour, and that this design is based upon using coal of 12,500 B. t. u. If the engine receives a tank of coal averaging 11,000 B. t. u., the rate of coal per square foot of grate per hour would immediately jump to 137 lb., at which point the curve is rapidly sloping away and proportionately a very large amount of coal must be added to secure a relatively small increase in total evaporation. Consequently the increasing rate of combustion interposes resistance to efforts to produce more power.

The condition thus cited is not an unusual one in railway practice. Reports show engines failing for steam on account of bad coal. As a matter of fact, the engines failed because the rate of combustion had to be forced above the possibilities of the grate. If our locomotives were designed for about 100 lb. per square foot of grate per hour for an engine designed with the boiler proportions about as indicated in Fig. 2 we would be working on a portion of the curve where there is all even slope, and there would be a margin for poor coal.

These are test plant figures and it may be urged that they do not reflect road conditions. A road test on 4-8-2 class engine on an important road gives results as shown in Table I. The average of three runs with an average train shows that 91.17 lb. of coal were burned per square foot of grate for the time the throttle was open. The average of three

TABLE I—RATE OF COMBUSTION AND EFFICIENCY FROM ROAD TESTS OF 4-8-2 LOCOMOTIVE

Run No.	Coal per sq. ft. grate time throttle open	Boiler efficiency (dry coal basis)
2	92.13	61.05
4	88.57	62.04
6	92.82	62.05
Average	91.17	61.71
10	124.76	55.51
12	129.36	51.01
14	120.26	57.93
Average	124.79	54.82

runs with a heavy train shows that 124.79 lb. of coal were burned per square foot of grate while the throttle was open.

This indicates conclusively that in actual practice we are duplicating test plant conditions set forth in Fig. 2. It is also important to note that the average boiler efficiency for the lower rates of combustion was 61.71 per cent, whereas when the boiler was forced and the rate of combustion was 124.79 lb. per square foot per hour the efficiency of the boiler fell off to 54.82 per cent. Grate area has become the most important single limiting factor in locomotive development. How to increase it and still meet wheel load conditions is the problem locomotive designers are facing.

History repeats itself. In 1895 the Chicago, Burlington & Quincy found its rate of combustion mounting to 200 lb. of coal per square foot of grate per hour. Engine No. 590 with a wide firebox reduced it to 112 lb. to do the same work. We have again reached the firebox, the grate area limit. We are again forcing locomotives beyond the point of economical operation. We are burning coal at from 140 to 180 lb. per square foot of grate area per hour. Think back to the arguments that brought wider fireboxes 25 years ago. Furnace limitations brought improvement then. They call for improvement now. We caught up then by adding a trailer axle.

Another trailer axle appears to be our recourse now. Other improvements have delayed this necessity but we must now catch up with the improvements.

The locomotive design illustrated in Fig. 3 shows a proposed solution of the problem which has not yet been worked out in practice. This is the result of a large amount of study and planning. It is designed to permit of any desired size of firebox within ordinary limits of width and length. Stokers can be used and the booster applied and still not exceed prevailing trailer load limits. Fundamentally, the design consists of an articulated frame, the articulated point being placed back of the rear driving wheels. The frame members under the firebox are placed outside of the trailing wheels, thus giving maximum ashpan space and permitting an easy and desirable booster, stoker and foot plate application. The cab, ash pan and cab parts are carried on supports attached to the boiler mudring. Suitable bearings are placed at the rear of the firebox connecting with the articulated frame.

This design removes the limits imposed by the single trailing axle. It permits of a grate and firebox design to suit any coal conditions and any desired rate of combustion; it allows an increase in ashpan capacity of from 75 to 100 per cent. It reduces to a minimum the lateral offsets on curves between the rear engine frame and the tender.

This Lima 2-8-4 type locomotive was designed for a limiting load of 54,000 lb. per axle. It has the following principal characteristics:

WEIGHTS IN WORKING ORDER	
Engine truck	29,000 lb.
Drivers	212,000 lb.
Trailer unit (front wheels)	28,000 lb.
Trailer unit (rear wheels)	53,000 lb.
Total	322,000 lb.
Heating surface—firebox, syphons and arch tubes	375 sq. ft. approx.
Heating surface, tubes and flues	3,162 sq. ft.
Heating surface, total	3,537 sq. ft. approx.
Superheating surface	915 sq. ft.
Grate area	76.2 sq. ft.

Locomotive wheel action on the rail calls for a study of the wave effect of the weights imposed by the various wheels. Fiber stress in rails is affected by two things other than speeds: First, the weight on each individual locomotive wheel and, second, the distance between the points of application of those weights. Progress of the locomotive on the track produces waves in the track. The track reacts, as much as it has time to react, after each wheel passes. Trailing wheels are far enough behind the drivers to allow the track to spring upward behind the rear drivers. The trailers knock it down again. Because of this, trailer weights are most important and so also is the distance between the trailer wheel and the rear driver. If trailer wheels carry say 75 per cent of the average weight on driving wheels the rail stress produced by the trailers becomes almost as great as the stress from the drivers themselves (American Railway Engineering Association Proceedings, Volume 21, 1920, page 719). This strongly supports the suggestion of four wheels under the firebox with wheel spacing and wheel loads that will prevent the destructive track effect of present trailer practice by an additional pair of wheels which will tend to keep the track down until the second trailer axle has passed. The four wheel articulated trailer promises to help to answer this rail problem.

Tradition says that the locomotive must be as simple as a grindstone. Railroad operation today says that it must be powerful and efficient. Power and efficiency in locomotives are not to be had except by complication, by adding to the locomotive factors that increase power that cannot be added in any other way and factors that save waste that cannot be saved in any other way. Every one of these factors increases weight. This weight must be provided for. In my opinion the four-wheel articulated trailer is the solution. We have put the additional carrying wheels under the wrong end of the engine. Why not put them where they are most needed, under the business end, under the firebox?

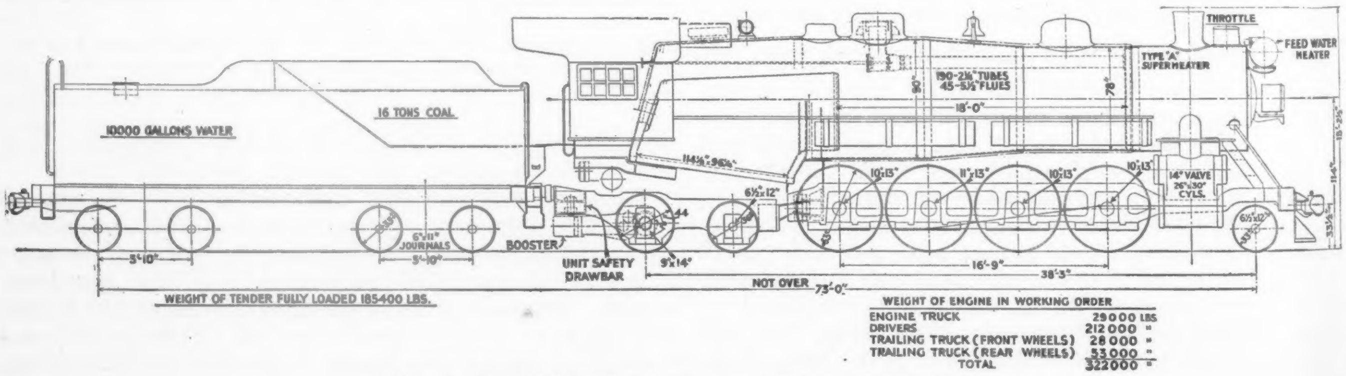
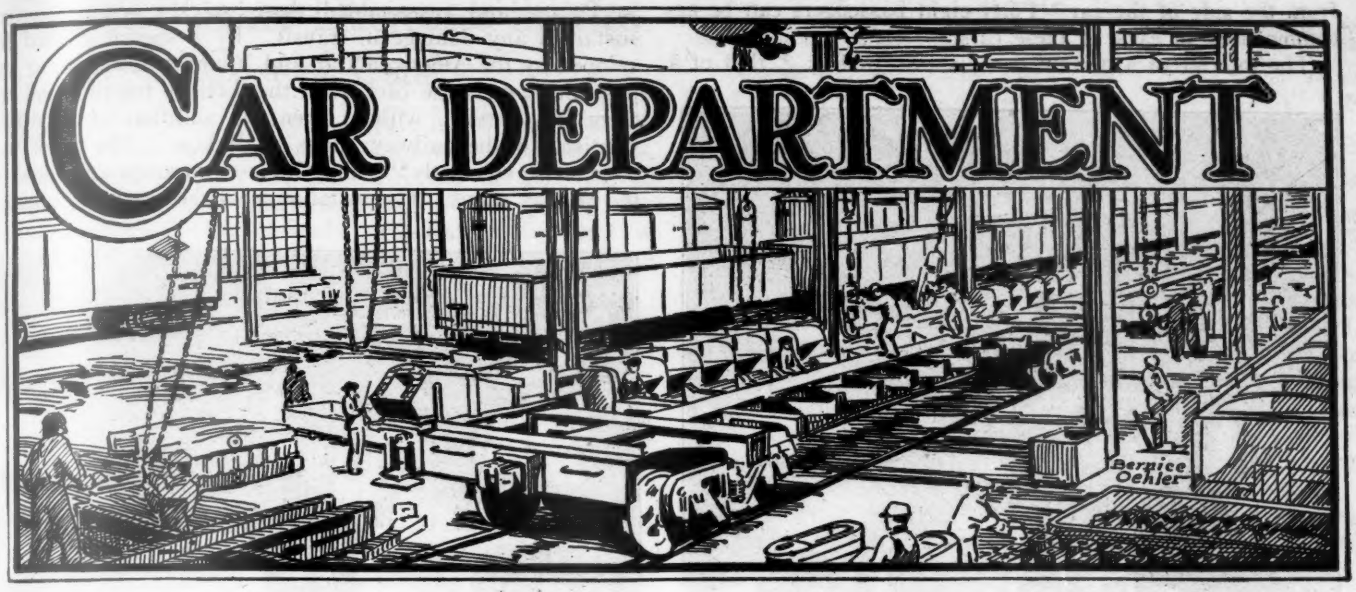


Fig. 3—Proposed Design to Overcome Firebox Limitations



De Luxe Passenger Cars for Chinese Railway

Modern Steel Equipment Conforming to American Practice Built for the Tientsin-Pukow Line

THE Tientsin-Pukow Railway, owned by the Chinese Government, is one of the most important north and south lines in China, the Pukow terminus being on the Yangtze river opposite Nanking, while Tientsin is the port of Peking. The American Car and Foundry Export Company has supplied five trains de luxe to this road, all of the cars being of steel. The total order includes 43 cars: 10 first-class, 10 second-class and 10 third-class sleeping cars; 5 drawing room and sleeping cars, and 5 dining cars, all of which were 72 ft. 6 in. long. There were also 3 private cars, 76 ft. 6 in. long.

The general design of the cars is the selection of the director general of the railway and his associates, all of whom are Chinese. In general, they have adopted the American arrangement of floor plan in the dining cars, while for the sleeping cars compartment sleepers are used for each one of their three classes—first, second and third.

An exterior view of one of the private cars is shown in Fig. 1. In outside appearance, all of the cars are similar. An arched roof is used, and the roof is built with double carlines so that there is a free circulation of air between the steel ceiling on the inside and the outer sheathing.

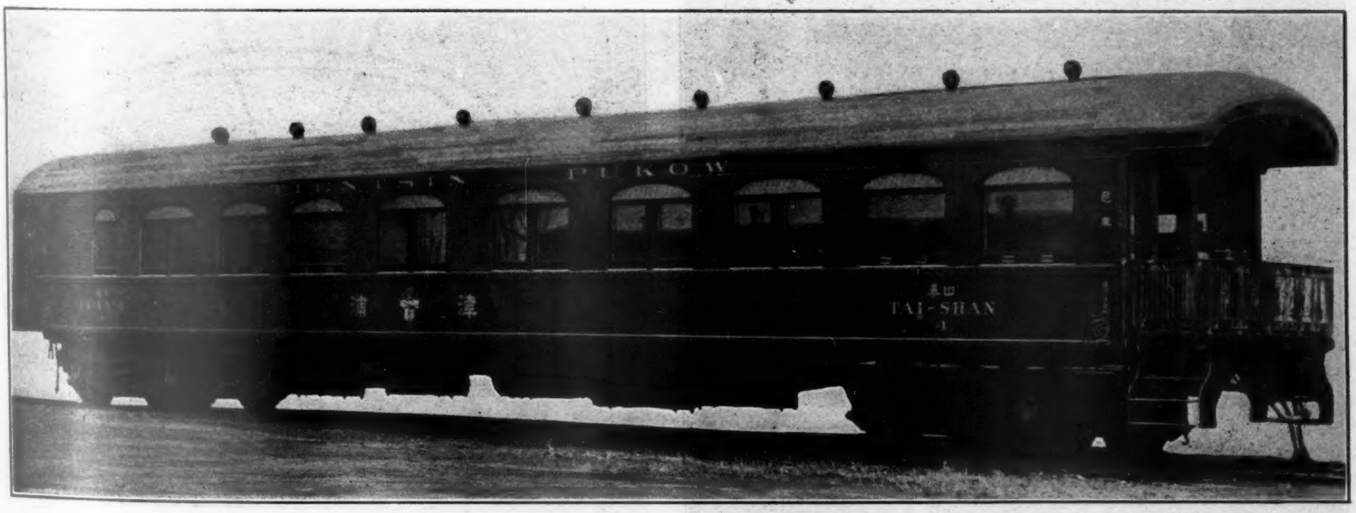


Fig. 1—A Private Car of Modern Construction for the Tientsin Pukow

In the first-class compartment sleeping cars, each compartment has its own lavatory and the beds are placed transversely, instead of longitudinally, in the car. The capacity of this type is 16 passengers per car.

In the second-class compartment, The Mann type of berth has been used, two upper and two lower berths per compartment. The backs of the sofa seats fold up to form the upper berth. There are seven compartments in each car, making the total capacity 28 passengers.

In the third-class compartment, each compartment has six berths, one formed by the sofa seat, one by the sofa back, and the topmost one by a hinged berth swinging out

from the side of the car. Forty-eight passengers can be accommodated in each of these cars.

The interior of a private car is shown in Fig. 2, that of a first-class compartment sleeping car in Fig. 3, of the dining car in Fig. 4, and a section of a combination drawing room and a sleeping car in Fig. 5.

Fig. 2—Interior of Private Car

All of the cars are modern throughout, having steel construction, electric lights, steam heat, and equipment along the lines of the best practice in this country. A four-wheel truck with steel frames is used for all the cars.

Fig. 3—Interior of Compartment in First-Class Sleeping Car

This equipment was completely erected and varnished inside and out in the American Car and Foundry Company's shops at Wilmington, Del., before shipment. The cars were dismantled and shipped in sections from Wilmington, Del., to Pukow and reassembled there quickly without having sustained any damage in transit. By a special method developed by the American Car and Foundry Company it was possible to erect the cars, rivet the sections together and put them into service, without even the addition of a coat of varnish, in the railway shops at Pukow. The work was done most efficiently by the Chinese workmen employed in the railway shops. The installation of the heating equipment and a very large amount of plumbing work, and the electric lighting installation, wires for which were run in conduits, presented no difficulties at all to the force of workmen who were employed.

Fig. 4—The Dining Cars Conform to American Practice

The American Car and Foundry Company has recently built at the Wilmington, Del., shop narrow gage steel cars for the Chilean State Railways. As in the above, these cars comprised among others sleeping cars of modern steel construction, fully equipped in the builder's shops, and then taken apart in sections, boxed, and shipped by sea to Coquimbo, Chile. These cars arrived at Coquimbo a short time before the earthquake and tidal wave, and by reason of the congested condition of the Coquimbo shops, they were erected about 100 miles along the line from Coquimbo. Because of this the cars were not destroyed, while the larger part of the equipment in Coquimbo simply disappeared, being swept away by the tidal wave.

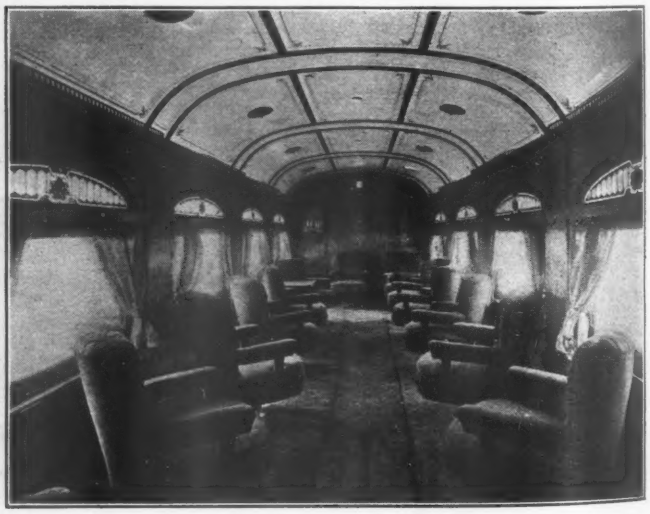


Fig. 5—Interior of a Combination Drawing Room and Sleeping Car

Treated Timber Decreases Service Cost of Cars*

Wood, which is subject to decay, is used more extensively in car construction than any other material, and a detailed study of this subject reveals the fact that 82 per cent of all timber removed from cars was removed because of decay. Consequently preservative treatment of car material must be given consideration by the officials of all railroads.

The two important phases of this subject are the cost and the effect on the lading. Obviously the lading of stock, flat or coal cars will not in any way be affected, regardless of the kind of treatment.

In 1918 the Marsh Refrigerator Service Company, Milwaukee, Wis., placed in service several refrigerator cars with creosoted sills, sub-flooring and roof boards and to date has not received any complaints about contaminated lading. In 1920 the Chicago, Burlington & Quincy placed in service four dining cars with creosoted sub-flooring. No contamination of foods or complaints of passengers have been noted on these cars. In view of these facts it is, then, safe to assume that the treatment of grain car sills will not cause contamination of the lading.

We have, then, the following material that can be treated by any process desired without any contamination of lading:

Sills for stock, flat, coal, grain and refrigerator cars; posts for stock, coal, grain and refrigerator cars; flooring for stock, flat and coal cars and sub-flooring for refrigerator cars, and roof boards for refrigerator and stock cars.

In our consideration of the treatment of this material the only question is, "Will it pay?"

Answers to questionnaires sent to the mechanical superintendents of the leading railroads bring out the following facts as to the average life of certain parts of cars:

Stock car decking	2 to 6 years
Stock car sills	5 to 8 years
Stock car roofing	4 to 6 years
Stock car side posts	4 to 6 years
Stock car end posts	6 to 8 years
Flat car decking	6 to 8 years
Refrigerator sills	4 to 5 years
Refrigerator sub-flooring	3 to 4 years

No one claimed more than 8 to 9 years life for any of the above parts.

Unfortunately there has been very little treatment of car material, so this committee is not in position to offer any conclusive evidence of the average life of treated material. However, in 1911 the Chicago, Burlington & Quincy placed in service 200 stock cars with treated sills and decking (treated by the Bethell process, 12 lb. of creosote per cu. ft.) and to date not one of the treated sills has been taken out except those that were broken in wrecks. None of the decking has been removed except that broken either by heavy loading or wrecks.

We feel sure that well treated sills and posts on all classes of cars will never have to be renewed, except as they are broken in wrecks, and we know that the Burlington will get an average life out of their stock car decking (subjected to harder usage than any other with the possible exception of refrigerator decking) of at least 16 years. The majority of this decking, after 12 years' service, is in perfect condition today. It is certain to give further service for at least the normal untreated life, or four years additional; therefore, we may expect at least 16 years' life.

Using the above figures of four years as the average life of untreated stock car decking and 16 years as the average life of treated stock car decking, the costs are as follows:

Untreated	
648 ft. b. m. (36-ft. car) at $40 per M	$25.92
Labor laying deck on car	7.50
Total cost	$33.42
Cost per year	8.36
Treated	
648 ft. b. m. (36-ft. car) at $40 per M	25.92
Treatment of 648 ft. b. m. at $15.43 per M	10.00
Labor laying deck on car	7.50
Total cost	$43.42
Cost per year	2.71

These figures on the cost of treatment are based on the cost of treating fir lumber with the straight creosote process at the Galesburg treating plant in the month of April, 1922, and include the following costs: unloading lumber from car to ground for seasoning; loading seasoned lumber from ground to tram for treatment; loading treated lumber from tram to car for shipment; supervision and overhead of operating treating plant, and preservative absorbed by the lumber (12 lb. creosote per cu. ft. at 12 cents per gallon).

There are probably as many different methods of figuring the cost of treatment as there are organizations using treated material. However, this committee cannot nor is it appointed for the purpose of extensively working up data as to the best methods of figuring cost. The above method is used, not to show the exact saving, but to form a working basis from which to prove that there will be a saving. We wish to call attention to the fact that it does not figure the cost of equipment nor does it make any allowance for the legitimate profit to which a commercial firm would be entitled.

The above is the highest priced treatment known. Treating with an empty cell process, 6 lb. creosote per cu. ft., the cost of treatment would be reduced $4.39. Treating with the Card process, 3 lb. creosote, ½ lb. zinc chloride per cu. ft., the cost would be reduced $5.78. Treating with the Burnettizing process, ½ lb. zinc chloride per cu. ft., the cost would be reduced $7.97.

As previously stated the committee is handicapped by lack of data as to the number of years' life obtained by treatment but let us assume for the time being that we may expect 16 years' life from stock car decking treated by any of the above processes, we find that the yearly maintenance costs are:

Untreated decking	$8.36
Bethell process treated decking	2.71
Empty cell treated decking	2.41
Card treated decking	2.33
Burnettizing treated decking	2.19

The above figures do not represent all of the saving. In these figures there has been no consideration of the loss of service of the car while it is in the repair yards having decayed parts renewed, neither has there been any consideration of the destruction of other material that is in good condition necessitated by the renewal of bad order parts. Another point that cannot be given definite figures is the saving effected by holding down the price of the car material. The price of timber, the same as any other commodity, is governed by the supply and demand. By conserving the supply and cutting down the demand, which we can do by preservative treatment, it will be possible to hold down the price of lumber. The time has undeniably come when the necessity for the conservation of our forest supplies makes it prohibitive for us to use untreated lumber any place where we can appreciably increase its life by preservative treatment.

To give the lowest possible annual maintenance car material must be treated by one of the standard pressure processes. While it is true that dipping, spray or brush treatments will increase the life of timber, it is also true that by pressure treatment the life will be so much further increased that the extra cost will be entirely warranted. This is particularly true with fir and hardwoods.

The collection of data based on results obtained over a

*Report presented by the Committee on Car Material at the nineteenth annual meeting of the American Wood Preservers' Association, held at New Orleans, La., January 23-25, 1923.

period of several years by different processes is necessary in order to definitely decide what treatment will be the most practical. However, at the present time the committee believes that treatment should be made by one of the processes using creosote, and are further of the opinion that full cell treatment by the Bethell process will give a bigger net absorption than is necessary. However, where the ideal treatment is not available, one of the inferior treatments would be a profitable investment.

We recommend that in the construction of new cars, the treatment outlined above be applied to all material that can be treated without harmful contamination of lading. We also recommend that a sufficient stock of treated standard material be kept on hand at the repair shops to be used in making repairs to bad order cars.

The committee is composed of the following members: F. S. Shinn (C. B. & Q.), chairman; K. C. Barth, Service Bureau, American Wood Preservers' Association; H. C. Bell (N. & W.); S. M. Elder (B. & O.) and Frank McCrory (C. R. I. & P.).

Lumber for Italian Passenger Cars

THE kinds and quantities of the different woods employed in building a passenger car for the Italian State Railways are treated in considerable detail by Ing. Gaetano Castlefranchi in a recent issue of Il Legno, an Italian lumber-trade magazine. The article is especially interesting because of the detailed analysis of the available varieties of wood and the cost.

The car with which the article deals is the standard third-class coach used for most passenger traffic on the main lines. It has four compartments at each end, a lavatory in the middle and a corridor running along the side.

Six woods enter in the construction of these carriages: Teak, oak, elm, Southern pine, fir and walnut. The frames are teak, the Siam variety being considered the most desirable since it is easily worked and has few defects. Java teak has too many knots and wormholes. The interlacing fibres of Borneo teak make it too liable to crack when worked. African teak—not related to true teak—might be serviceable, but is almost unknown in Italy and would have to be imported in considerable quantities of selected and uniform grades before judgment on its adaptability could be rendered. Walnut can not be used for the frame because it rots too readily when brought in contact with nails or bolts.

Southern yellow pine has been found best for siding. European larch could not well replace Southern yellow pine, because the former wood has so many knots that its yield in usable sheathing would make the ultimate expense unduly high.

Such woods as beech, maple, linden, cherry and sycamore, as well as several kinds of Italian lumber, which on first thought might serve as carsiding, are out of the question since experience has shown that, when worked, they warp or split easily. Well-seasoned beech has not been given a sufficient trial for manufacturers to be assured regarding its fitness, but Italian experts believe that this wood, even after being seasoned, is likely to rot when exposed to moisture.

When the cost of the lumber placed in the finished carriage is derived from the price and quantity as purchased in its original marketable form, according to Italian mill practice, it must be considered that the cubic volume of the purchased lumber runs from 130 to 135 per cent of the volume of the finished wood finally used. For example, sawing oak logs into boards fit for use gives percentages of the weight of the original logs in various products, as follows: Bark, 7; sawdust, 8; firewood, 17; chips, 10; general waste, 20; finished boards, 38. Since, on the basis of a 38 per cent yield of boards from the logs and a cost of the latter at present coming to 34 lire ($1.73) per 100 kilos (220.5 lb.), the 380 kilos (838 lb.) of boards obtained from a metric ton (1,000 kilos, or 2,204.6 lb.) of logs would cost 340 lire ($17.34), plus 90 lire ($4.59) for labor and general expenses, or a total gross cost of 430 lire ($21.93). However, this gross cost is subject to a reduction of 52 lire ($2.65), the selling value of the by-products, since the prices of the sawdust, firewood and chips are, respectively, 8 lire, 16 lire, and 21 lire ($0.41, $0.82 and $1.07) per 100 kilos. Consequently the final net cost of the 380 kilos of boards obtained from a metric ton of oak logs amounts to 378 lire ($19.28), or 0.98 lire ($0.05) per kilo (2.205 lb.). At this price, a cubic meter (35.3 cu. ft.) of oak boards, taken as weighing 920 kilos (2,028 lb.) would cost 900 lire ($45.90). To this cost should be added further losses and expenses due to milling, sampling, seasoning, etc., which would bring the cost per cubic meter to 990 lire ($50.49) or $119.08 per 1,000 ft. board measure.

Commenting on the calculation of the yield in finished material from an original given weight of logs, it is admitted that the proportion of finished boards may seem rather low, but in arriving at the results, ample allowance was made for knots, other defects, etc.

While oak logs give only 38 to 40 per cent finished material for car construction, and Slavonian oak planks 60 per cent, Southern yellow pine timber yields 54 per cent.

The quantities, prices, and costs of the lumber used in building a third-class carriage, are given in an accompanying table.

The oak used in the calculations of this table comes from Slavonia, Jugoslavia. While this imported lumber has a higher price, 560 lire ($28.56) per cubic meter, than Italian oak, priced at 480 lire ($24.48), the latter gives a yield of only 51 per cent in usable material as against a yield of 60 per cent for Slavonia oak. The amount of Italian oak planks which it would be necessary to buy would be 2.26 cubic meters, as compared with 1.90 cubic meters of Slavonia oak planks, in order to provide the 1.13 cubic meters of finished material required.

KINDS AND QUANTITIES OF LUMBER USED FOR THIRD-CLASS CARS

	Teak	Oak	Elm	Southern Yellow Pine	Fir	Walnut
1. Volume of finished material required, cubic meters	8.60	1.13	0.65	4.1	2.25	0.035
2. Form of lumber purchased	Boards	Large planks	Large planks	Timbers	Boards	Large planks
3. Purchase price of lumber, lire per cubic meter	2,600	560	430	630	295	1,000
4. Percentage yield of finished material from lumber, per cent	67	60	51	54	60	75
5. Unit prime cost of finished material required, lire per cubic meter	3,880	930	860	1,160	490	1,330
6. Unit labor cost and general expense, lire per cubic meter	100	100	100	100	100	100
7. Value of marketable waste and by-products, lire per cubic meter	70	55	50	40	35	40
8. Net unit cost (items 6 minus 7) of finished material, lire per cubic meter	30	45	50	60	65	60
9. Total unit cost (items 5 plus 8) of finished material, lire per cubic meter	3,910	975	910	1,220	555	1,390
10. Amount of lumber purchased to provide required quantity (item 1) of finished material, cubic meters	12.9	1.9	1.13	7.6	3.46	0.06
11. Total cost of lumber purchased (item 3 times item 10) Lire	33,540	1,064	486	4,788	1,110	60
Total	41,048 Lire ($2,093.45)					

The grand total cost of all lumber used equals 41,048 lire ($2,093.45). The value in lire per cubic meter multiplied by 51 and divided by 424 will give the value in dollars per 1,000 board feet at the December, 1922, rate of exchange, according to which the lire equaled $0.051.

Thermal Stresses in Steel Car Wheels

Results of Investigation by the Bureau of Standards to Determine Effect of Heating Due to Brake Applications

By George K. Burgess and G. Willard Quick

NINETEEN steel wheels have been tested in the laboratory of the Bureau of Standards under conditions approximating those encountered in service caused by heavy brake applications. The rims of the wheels were heated to a temperature of 380 deg. C. (716 deg. F.) by passing an electric current through a band of soft steel encircling the wheel. The resulting stresses were calculated from strain-gage measurements after correcting for thermal expansion. Eight worn wheels and eleven new wheels representing five types of manufacture were tested and none failed in the tests. As a result of heating the rim, the hub moved with respect to the rim, inducing tensile stress on the face and compression on the back near the hub. Near the rim the stresses were in compression on the face and in tension on the back except for worn wheels where no stress was induced on the face. The maximum surface stresses developed were slightly above the yield point of the material, producing a permanent set for the first tests on new wheels while no set resulted from tests on old wheels or in succeeding tests on new wheels.

This investigation was the result of a conference of representatives of several manufacturers and purchasers of steel car wheels held at the Bureau of Standards in 1920. Experienced railway men stated that the tread becomes heated to a dull red on long, heavy grades by the application of brake shoes. It was agreed that it would be of general interest and of value to investigate the stresses thus set up, the plan being to conduct the tests in a manner identical with the procedure followed in the investigation of Thermal Stresses in Chilled Iron Car Wheels* with some additional tests on steel wheels at as high a temperature as possible to obtain with the special equipment used and including also a survey of the stresses thereby induced in the back of the plate.

Fig. 1—Car Wheel in Test Stand Ready for Bureau of Standards Thermal Test

Other problems present themselves in connection with the subject of stress caused by brake application; as the effect of speed, shoe pressure and length of application in producing thermal stresses. At Purdue University an investigation of these problems, with the wheels revolving while a brake shoe is held in contact with the tread, is in progress. In the investigation at the Bureau of Standards the manner in which

*See *Railway Mechanical Engineer*, August, 1922, page 460.

thermal stresses build up in wheels, the magnitude, nature and location of stresses have been studied.

Wheels Tested and Method of Manufacture

The wheels were 33-in. steel car wheels representing the product of six different plants and five methods of manufacture. Two new wheels furnished by each of four different manufacturers, one new wheel and two special wheels —one with a thin web and one with a straight web—from

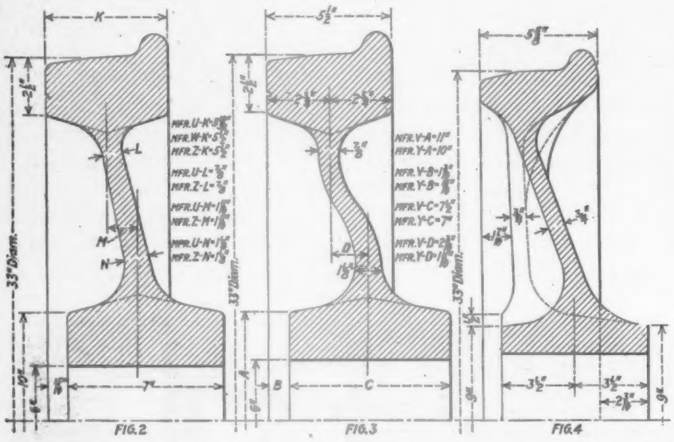


Fig. 2—Sections of Forged Wheels of Manufacturers U, W and Z
Fig. 3—Sections of Forged Wheels of Manufacturers V and Y
Fig. 4—Section of Cast Steel Wheels of Manufacturer X

another mill, together with eight worn wheels† representing the product of four different plants, made a total of 19 wheels upon which one or more series of measurements were made. The manufacturers co-operating have been designated by the letters U, V, W, X, Y, and Z. Table I gives a brief description of the method of manufacture. Fig. 2, Fig. 3, and Fig. 4 show sections of the various standard wheels.

TABLE I—WHEELS TESTED

Mfrs.	Method of manufacture
U	Forged and rolled from an individual ingot.
V	22 in. by 22 in. ingot rolled into 15 in. round which is sheared into blanks. The blanks are forged and rolled into wheels.
W	Ingot rolled into plates from which biscuits are cut. These biscuits are forged and rolled into wheels.
X	Cast in a revolving mold. First part of pour is high in manganese, forming the tread, while low carbon steel forms plate and hub.
Y	Same procedure as manufacturer V.
Z‡	90 in., 12 sided, fluted ingot with sand lined sink head is cut cold into blocks of proper weight. These blocks are heated in a continuous furnace after which they are forged and rolled into wheels.

Procedure for Thermal Stress Tests

In the thermal stress tests the wheel was mounted on a hollow water-cooled 6-in. axle. The axle in turn rested upon supports. A soft-steel resistor 3½ in. in width and ¼ in. in thickness was placed on the tread of the wheel, but insulated from it by a thin sheet of perforated asbestos, and an alternating current of 1,000 to 1,500 amperes at 15 to 30 volts was passed through it. Undue radiation of heat into the air was prevented by the use of asbestos covering. Fig. 1 shows the arrangement of this apparatus.

The tread of the wheel attained a maximum temperature of approximately 380 deg. C. (716 deg. F.) in each run. To determine the distribution of temperature in the wheel from tread to hub copper-constantan thermocouples of No. 30 B. & S. gage wire were used—seven couples along a vertical radius at approximately 2-in. intervals and seven others similarly located along the horizontal radius. Readings were taken along both radii for the purpose of obtaining duplicate results. Two other thermocouples were inserted into the tread of the wheel. Thus, four couples, one at the gap in the resistor, were placed at equidistant points in the tread of the wheel and assurance given that uniformity of tread temperatures was attained. The 16 copper-constantan thermocouples can be seen in Fig. 1, extending from the wheel to overhead supports and then down to the potentiometer on the transformer table.

A 2-in. Berry strain gage was used for measuring the deformations. Five or six sets of readings were taken at 1-in. intervals on the vertical and horizontal radii on both the face and back of the plate. The location of the points at which strain-gage and thermocouple readings were taken are shown in Fig. 5.

It was only necessary to survey the stresses along the radii of the wheels, since preliminary measurements had shown that the tangential stresses were of a compressive nature and of relatively small magnitude.

Identical rates of power input were maintained for each test in order to obtain comparative results. It was necessary to increase the power input near the end of the test to attain the desired tread temperature in a comparatively short time. The amount of power applied per minute during the different periods of the test was as follows:

First half hour	570,000 ft. lb.
Second half hour	690,000 ft. lb.
Third half hour	770,000 ft. lb.
Fourth half hour	797,000 ft. lb.

In these tests the resistor completely encircled the wheel and was thermally insulated. Under these conditions a larger percentage of the energy entered the wheel than would have been the case had the same wheel been subjected to brake application in service, due to the fact that part of the energy destroyed by friction between the shoe and wheel goes to heating the brake shoe, and thence by radiation to the air, and, further, the shoe only bears on a small part of the circumference, thus allowing the heat in the uncovered part of the tread to radiate instead of entering the wheel.

Readings were taken of the temperature, strain, and power input at regular intervals, a strain gage reading of the cold wheel being also taken before the test was started. When

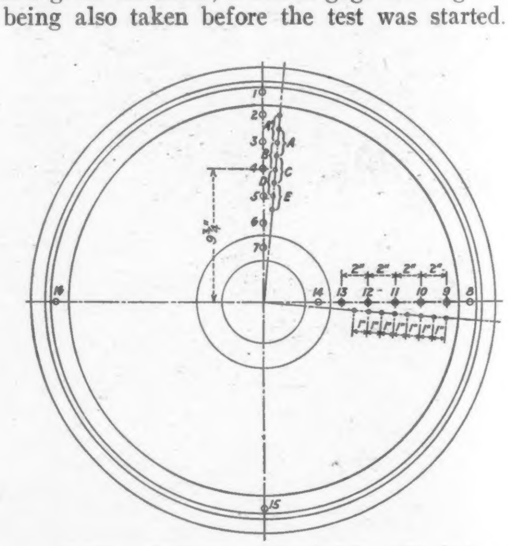


Fig. 5—Location of Thermocouple and Strain Gage Holes

the desired tread temperature was reached, the power was shut off and the asbestos covering on the resistor removed to permit more rapid dissipation of the heat. Temperature and strain gage readings were also taken during cooling and after the wheel was at room temperature.

The elongation as determined by the strain gage is attributable to two causes: (1) An elongation due to the thermal expansion of metal, and (2) elongation caused by the strain due to the temperature gradient from tread to hub of the wheel. By knowing the coefficient of expansion and the temperature rise it was possible to calculate the thermal expansion. By deducting the elongation due to this expansion from the total elongation, the elongation due to stress alone

†Furnished by the Pennsylvania Railroad.
‡One standard design, one thin plate, one straight plate.

was determined. The relation between stress and strain on samples actually taken from the wheels made it possible to convert the strain readings into stress values.

Physical Properties and Composition of Material

The coefficient of expansion of specimens taken from one wheel of every manufacturer was determined for the range from 20 deg. C. to 400 deg. C. (68 deg. F. to 752 deg. F.). An average of the results is given in Table II.

TABLE II—THERMAL EXPANSION OF WHEEL SECTIONS

Temperature rise		Composite total expansion inches per inch	
Deg. C.	Deg. F.	Forged or rolled	Cast
50	90	.00056	.00060
100	180	.00117	.00125
150	270	.00180	.00194
200	360	.00248	.00267
250	450	.00319	.00345
300	540	.00393	.00391

The mechanical properties of the steels were determined on two 8-in. gage-length specimens taken from the plates of one rolled steel wheel of each manufacturer, while 2-in. gage-length specimens were taken from a cast-steel wheel because, due to the corrugated plate it was impossible to obtain 8-in. samples. Table III gives the averaged results of the tensile tests.

TABLE III—AVERAGE RESULTS OF TENSILE TESTS

Mfr.	Yield point, lb. per sq. in.	Ultimate strength, lb. per sq. in.	Elongation in 8 in., per cent	Reduction in area, per cent
U	52,100	123,300	13.5	14.1
V	......	119,500	12.5	13.6
W	43,400	107,000	13.8	14.8
X	50,700	85,000	14.5	23.6
Y	53,300	122,000	11.2	10.5
Z	61,900	130,200	11.2	13.9

The modulus of elasticity averaged 29,260,000 lb. per sq. in. for the forged wheels and 30,500,000 lb. per sq. in. for the cast steel wheel.

The chemical composition of one wheel submitted by each manufacturer was determined. Drillings were taken from the plates of the forged steel wheels about midway between the hub and the rim. For the cast steel wheels, of varying compositions, ten drillings were taken across the whole diameter, No. 1 and No. 10 being in the rim, No. 5 and No. 6 in the hub and the others in the web. The results of the analyses are given in Table IV.

TABLE IV—CHEMICAL COMPOSITION OF WHEELS

Manufacturer	Position	Carbon	Sulph.	Phos.	Mang.	Silicon
U	3	.67	.019	.029	.77	.19
V	3	.73	.015	.028	.73	.21
W	3	.66	.014	.027	.67	.17
X	1	.32	.025	.023	1.60	.29
	2	.26	.019	.022	1.15	.29
	3	.25	.022	.022	.76	.28
	4	.18	.018	.019	.72	.28
	5	.20	.015	.021	.69	.24
	6	.25	.022	.021	.67	.28
	7	.20	.022	.020	.68	.28
	8	.24	.022	.023	.92	.28
	9	.21	.021	.020	.86	.27
	10	.30	.023	.023	1.66	.29
Y	3	.77	.032	.032	.69	.16
Z	3	.75	.026	.019	.66	.25

Brinell hardness determinations were made on radial sections cut from two rolled and from one cast type of wheel. Impressions were made at 1-in. intervals along the radius, the first one being about ⅛ in. from the rim. There was very little variation in hardness along the radial section of the rolled wheels, the average being about 250. For the cast wheel the hardness varied widely from rim to hub. These wheels were hardest near the rim and softer in towards the hub with a position quite deficient in hardness at the middle of the rim where shrinkage holes occurred. The Brinell hardness was 325 at ¼ in. from the tread, 250 at ¾ in., 220 at from 2 in. to 3 in. and 150 near the hub.

Results of Thermal Stress Tests

For the new rolled steel wheels of regular design the maximum stresses developed on the face of the plate were in tension near the hub and in compression near the rim, while on the back of the plate the conditions were reversed. These stresses are produced by expansion of the rim causing the hub to move relative to the rim. The average movement of the hubs of the standard design wheels ranged from .07 in. to .10 in. Fig. 6 shows typical time-stress curves for the face and Fig. 7 for the back of the plate of new steel wheels.

Of the two special wheels furnished by manufacturer Z

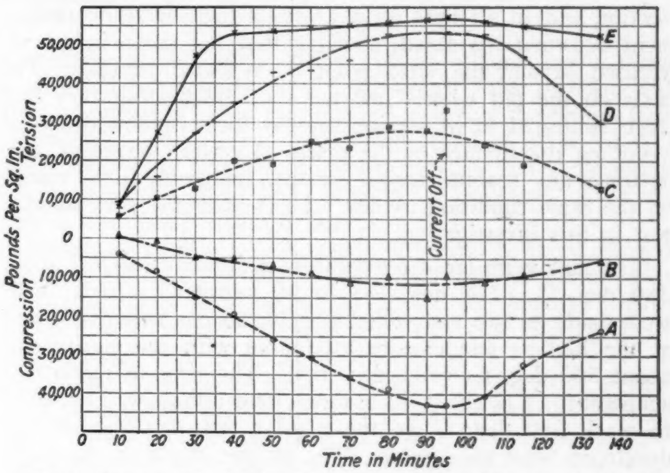


Fig. 6—Stress-Time Curves Showing Average Stresses Developed on Face of All New Wheels of Manufacturer Y (See Fig. 5 for Location of Measurements)

the one with a thinner plate developed stresses similar to but of somewhat greater magnitude than those developed in the wheels of regular design. The tread of this wheel was also lighter than that of the regular wheels. The stresses developed in the special wheel with the straight plate were in tension on both the face and the back of the plate.

For the worn wheels tested, in which considerable metal had been worn from the tread, the stresses developed on the face of the plate were in tension near the hub and gradually

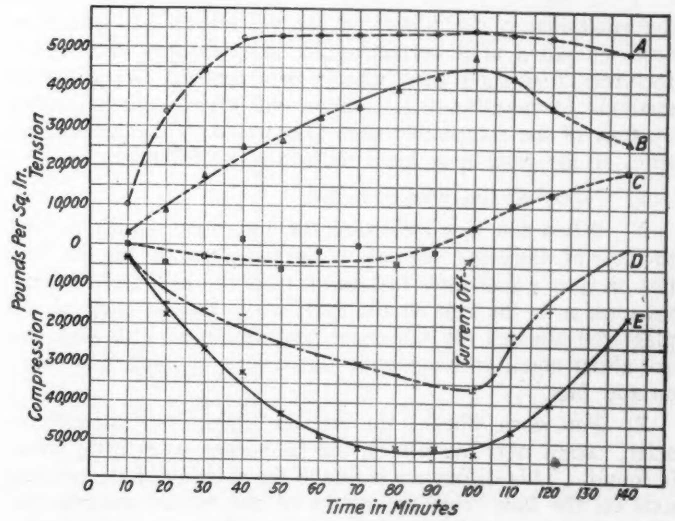


Fig. 7—Stress-Time Curves Showing Average Stresses Developed on Back of All New Wheels of Manufacturer Y (See Fig. 5 for Location of Measurements)

diminished to practically zero at the rim, while on the back of the plate the stresses were of about the same nature and magnitude as for the new wheels. The neutral axis on the face of the old wheels is shifted out towards the rim. This difference for worn wheels may be due to the work on the tread, static loads, impacts, the thinner tread or a combination of these factors.

In the tests on the cast steel wheels, the stresses were more

complicated because of the nature of the plate, which is of a corrugated design.

From the first test on new wheels, a permanent set was observed on the surfaces of the plates, at positions of maximum stress, indicating that the material was strained beyond the yield point at the points on the surface. The greatest compressive stress observed was 68,800 lb. per sq. in. and the greatest tensile stress 58,100 lb. per sq. in.

In succeeding tests on new rolled steel wheels of standard section and in all tests on old wheels there were no permanent deformations noted, showing that the stress is not increased beyond the yield point on repeated heating. The tests on the old wheels indicate that the heating they had been subjected to in service stressed them beyond the yield point on the surface of the plates at certain positions, and relieved any manufacturing strains, rendering these wheels in the same condition as new wheels after the first thermal test in this investigation.

The maximum tread temperature ordinarily reached about 380 deg. C. (716 deg. F.) in 90 minutes. Special tests were made on two new rolled wheels and one new cast wheel at the highest temperature attainable with the equipment, about 500 deg. C. (932 deg. F.). The time to reach this temperature was about 60 minutes longer than was required to reach 380 deg. C. in the regular tests but the stresses developed were no greater. The greater strain in the plate appears to be offset by greater expansion due to the higher temperature, thus giving a flat, stress-time curve between 380 deg. C. and 500 deg. C.

Summary and Conclusions

Nineteen 33-in. steel wheels have been tested in a manner approximating conditions encountered in service through long applications of brakes on heavy grades. In the tests the rims of the wheels were heated electrically and the hubs were kept cool by passing water through the hollow axle upon which the wheels were mounted. The maximum tread temperature was 380 deg. C. (716 deg. F.) in the regular tests and in the special tests a maximum temperature of 500 deg. C. (932 deg. F.) was attained. From observations of the deformations in the plates of the wheels the stresses have been computed after correcting for temperature. Six manufacturers furnished new wheels representing five different methods of manufacture. Eight old wheels manufactured by four of the companies were also tested. The general results of the tests may be summarized as follows:

1. None of the wheels failed.

2. When the rim is heated the hub moves with respect to the rim, inducing stresses in the plate which, for the first test on new wheels, are in tension near the hub and in compression near the rim on the face, while on the back of the plate the stresses for the same positions near hub and rim are about equal in magnitude but reverse in nature to those on the face.

3. For worn wheels, the stresses are of the same character, except near the rim on the face where very little stress is found. This difference is due to the shifting of the neutral axis on the face from the center of the radius towards the rim and is caused by conditions of service.

4. The maximum stresses were slightly above the yield point of the material as determined in tensile tests.

5. A permanent set was apparent only for new wheels on the first tests. For old wheels and in succeeding tests on new wheels, there was no set apparent, showing that the stresses above the yield point were not increased by repeated heating, and that the old wheels had been rendered, by service, in a condition similar to that of new wheels after the first thermal test.

6. For forged wheels the character and magnitude of the stresses developed in the surface of the plate are little affected by the method of manufacture. The stresses developed in the cast-steel wheels were, because of the corrugated form of plate, more complicated than those in the forged wheels.

The Bureau of Standards is undertaking a study of the residual stresses in steel car wheels from the manufacturing processes. In this work sections are being sawed from the wheels and stresses so relieved will be calculated from deformations measured with a strain-gage.

Permanent Head Boards Increase Privacy of Pullman Sections

THE first step in the development of greater privacy for sleeping car passengers during the daytime, now being undertaken by the Pullman Company, is shown in the illustration. Some 60 standard Pullman sleeping cars are now in service equipped with permanent head boards which extend out from the side of the car for something more than half the width of the seat, so that the forward edges are flush with the top of the closed berths and the side walls of the upper deck. The permanent head board adds considerably to the privacy of the standard section during the daytime. It also permits the occupants of each section to freely control the ventilation without causing drafts which may be displeasing to the occupants of adjoining sections. At night the partition is completed by locking a removable half head board on the rigid partition. The berths are made up in the usual way.

Sections of Standard Pullman Sleeping Cars Separated by Permanent Head Boards

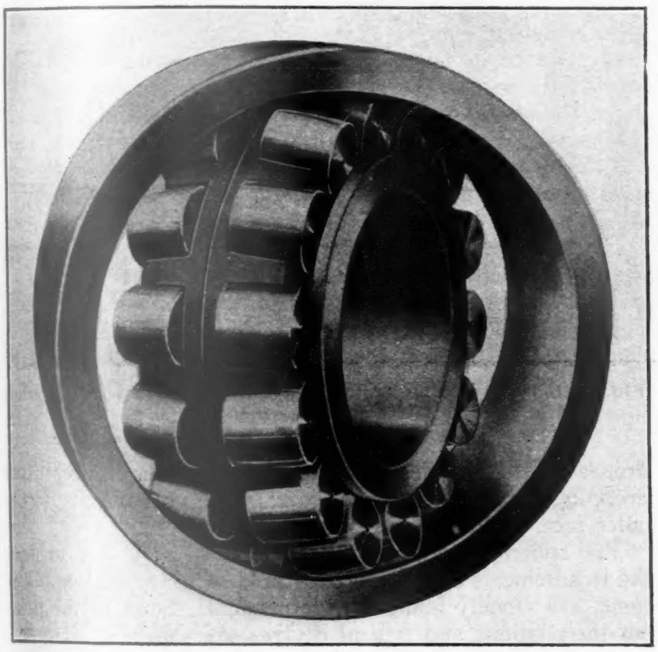
The arrangement illustrated has been received with favor by travelers wherever the cars of this type have been in service and experiments looking toward the further development of the idea are now under way at the Pullman Works, Chicago.

Advantages of the Spherical Type Roller Bearing

A New Design Which Combines Self-Alinement, Low Frictional Resistance and High Capacity

By H. E. Brunner
Chief Engineer, S-K-F Industries, Inc.

ANTI-FRICTION bearings have found limited application in railroad work in the past principally because the shocks which bearings on locomotives and cars receive are unusually severe. Numerous attempts have been made to develop special bearings adapted for such service but in general they have not been successful. The conditions under which the bearings on freight and passenger car journals and railway motor shafts operate require a bearing



Spherical Roller Bearing, with Inner Race Turned to Show Construction

with the low frictional qualities and precision of a ball bearing combined with load carrying capacity comparable with that of a roller bearing but not obtained at the sacrifice of true rolling or by enforced rigidity. A new design of roller bearing which combines these characteristics has recently been placed on the market. As sufficient experience has already been had in a large variety of heavy machines to establish its merit, the purpose of the present article is to describe the construction and to analyze the design from a technical point of view.

The Aktiebolaget Svenska Kullagerfabriken of Gothenburg, Sweden, undertook in 1918, to study the problem of anti-friction bearings for heavy duty service. A careful analysis was made of the limitations affecting both the ball and the roller bearing in applications of the kind in question. This was followed by extensive tests of a large number of different types of bearings, the results of which were systematically studied. In this way there were discovered certain desirable characteristics of the various types and likewise objectionable ones, from the point of view of the heavy type of service for which it was necessary to provide.

With the conclusions of this experimental work at hand, the task was to devise a bearing which would incorporate the maximum number of desirable features without any of those which had been found to be detrimental. The problem was further extended by the necessity of adapting the design thus developed to the already established standard sizes for ball bearings. This was accomplished with notable success and the "spherical type of roller bearing" is the result of the research and study outlined above.

Referring to Fig. 1 a longitudinal section through the mid plane of the bearing will be seen. Part A is the inner race of the bearing. It is secured to the shaft or journal according to the usual methods employed with ball bearings operating under corresponding load and speed conditions. A shrink fit, press fit or tapered sleeve, together with a suitable locknut may be used. Parts R are the two rows of rollers. Part B is the outer race, ground spherical on the inner surface from the center point O of the bearing. The outer race of the bearing is mounted in the housing according to the usual method for a ball bearing, which normally provides a slight clearance to facilitate creeping of the race in the housing while in service.

It will be seen from the figure that the bearing is a self-contained and self-alining unit, two properties that are of

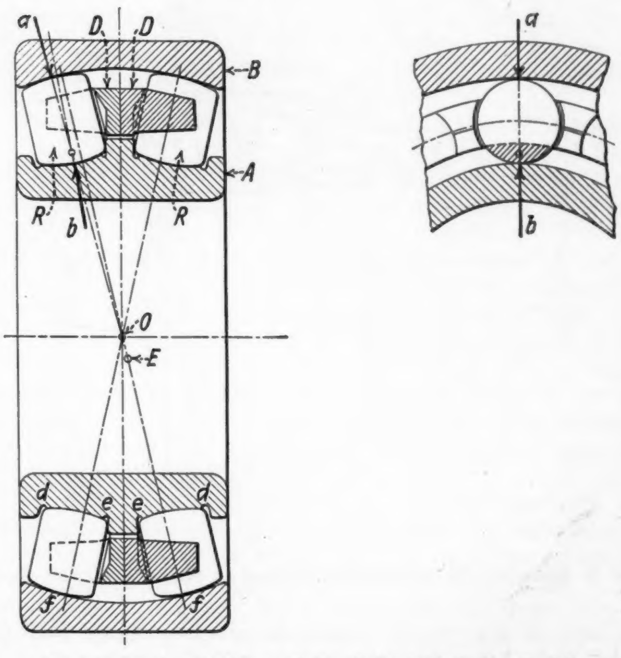


Fig. 1—Sectional Views of the Spherical Roller Bearing

the greatest importance. The former means that when the bearing is being installed, there is no adjustment required internal to the bearing itself, thus precluding the possibility of damage through initial maladjustment. The spherical surface of the outer race provides for self-alinement of the bearing to compensate for shaft deflections and unavoidable inaccuracies in machining and locating the housings. These two features are of particular importance in the field of heavy machinery, for which the bearing is designed.

The internal construction of the bearing will be made clear

by further reference to Fig. 1. On the inner race the roller *R* contacts with the groove *de* throughout its length thus providing the line contact of the roller bearing. On the outer race the roller contacts at the point *f* and due to the closeness of the roller curvature (in a longitudinal plane) radius *Ef*, with the race curvature radius *Of*, the contact is very intimate. It will be seen that the rollers are barrel shaped and have their largest diameter toward the inboard end. Actually the contact between the roller and the outer race will be a substantial area, due to the elasticity of these parts, and consequent deformation under load. From this it will be seen that the spherical type roller bearing embodies the theoretical characteristics of both point contact of the ball bearing and line contact of the roller bearing. The desirability of this combination of point contact on the outer race with line contact on the inner race was one of the conclusive results of the experimental work which preceded the development of this bearing. It should be observed that the line contact is provided on the inner race, which as is well known, is the weaker element on the typical type of annular bearing. The result is an excellent equalization of stress between the inner and outer races.

Any type of bearing which aims to obtain line contact must provide some means for maintaining the parallelism of the axes of the rollers with the shaft. Otherwise the skewing of the rollers destroys the line contact and substitutes a very objectionable form of point contact. In the spherical type of roller bearing the axes of the rollers are held parallel with the axis of the shaft in a positive manner by means of the guiding flanges *ee* on the inner race. Referring to Fig. 1, it will be seen that both the flanges *ee* and the ends of the rollers are ground spherical surfaces, with their center at the point of intersection of the shaft axis and

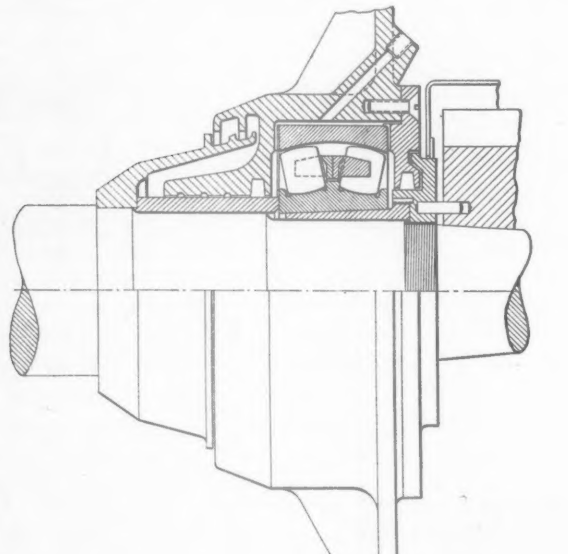


Fig. 2—Spherical Roller Bearing Applied to Motor Armature Shaft

the axes of the rollers. Since the guiding flange and the roller ends have the same center and the same radius of curvature, they contact over an area shown at *g* in the end view. The arrows *a* and *b* which represent the resultant forces on the roller from the outer and inner races, respectively, are inclined to one another by a small angle. (The included angle of the cone circumscribing the roller.) This means that there is a wedging force holding the roller in contact with the guiding flange and developing the reaction *C* at the center of the area of contact with the guiding flange. As soon as a roller skews in the slightest degree there is no longer a contact area between the end of the roller and the guiding flange. The contact is then at a single point on the edge of the roller, and the force *C*, together with the resultant of the inner and outer race reactions *a* and *b*, forms a couple which immediately counteracts skewing tendency and returns the roller to its position of equilibrium. The rollers are maintained in a parallel relation with the shaft axis by this positive action, which provides in the design of the bearing itself, a stable equilibrium of the roller. The advantage of this provision is immediately reflected in the low coefficient of friction shown in tests of the bearing; this being somewhat greater than that of a ball bearing, but markedly lower than in other types of roller bearings.

The retainer *D* is carried on the land of the inner race and serves only to separate adjacent rollers and to prevent their contacting with one another. The retainer is usually made of

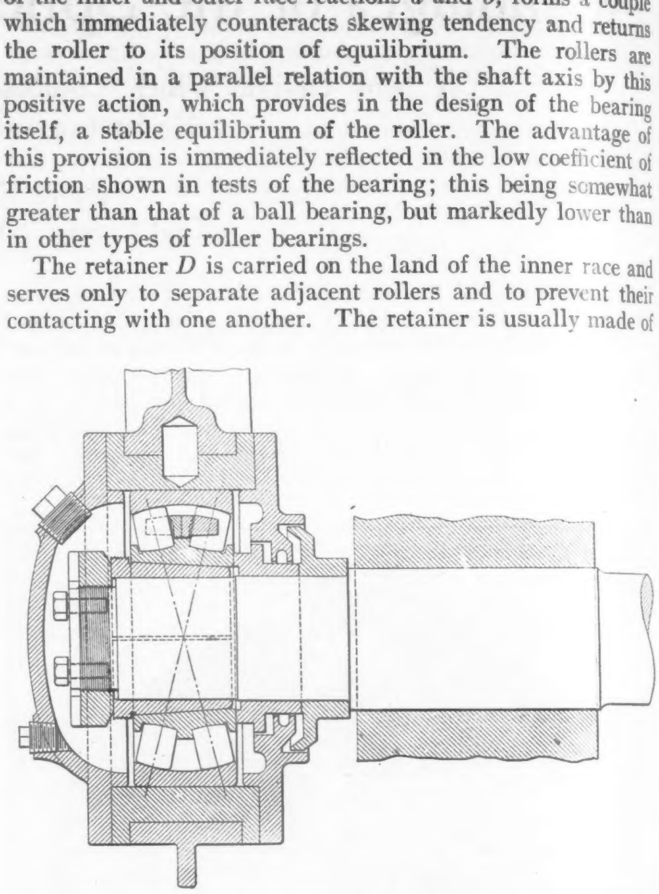


Fig. 3—Journal Box for Motor Rail Car Equipped with Spherical Roller Bearing

bronze and is so designed that it holds the rollers from dropping out when the inner race is deflected relative to the outer race, as for cleaning.

The spherical roller bearing, developed as it was to meet the requirements of a specialized field of heavy duty applications, has already found a wide demand. Some of the present installations and typical designs are shown in diagrams herewith.

Fig. 2 illustrates an electric railway motor with a spherical type roller bearing on the pinion end of the armature shaft. The inner race is secured to the shaft by means of a tapered sleeve. A ball bearing is used on the opposite end of the shaft where loads are comparatively light for the given space limitation.

Fig. 3 illustrates in principle the method of applying the spherical roller bearing to a motor rail car. Because of its self-alining quality the bearing is particularly well adapted to the construction employing a journal box clamped in the pedestal. An unrestrained mounting can be had by employing this bearing in the rigid box as shown. The advantages derived are immediately evident in the greater flexibility of the truck and the reduced stresses which are imposed upon the bearing.

Careful consideration has been given the means of securing the bearing to the journal so as to permit of easy installation and at the same time providing a positive locking of the bearing to the shaft. The tapered adapter sleeve together with the very substantial lock nut and key should appeal to the railroad man because of its extreme simplicity and absolute security.

The dust guard is specially designed to permit of proper functioning under conditions of misalinement between the box and journal. The conventional double lip and groove

in conjunction with the internal flinger provide for the retention of the lubricant.

The spherical type of roller bearing is equally well adapted to trucks employing the standard types of pedestal construction. Such design insures flexibility in a greater degree than that now obtained in standard practice. It appears to offer a possible solution to the problem of providing a less rigid truck construction, particularly in the field of motor rail cars.

Attention is directed to the provisions for excluding dust and dirt from the housing and for prevention of leakage of the lubricant. The latter consideration is of particular importance in the motor mounting shown in Fig. 2.

It is believed from the experience had with the operation of this type of bearing to date, that its field of application will be broadened beyond the scope originally contemplated in the design of the bearing. This applies particularly as regards the speed rating. It has further been found that, in equivalent sizes the spherical roller bearing has about twice the load capacity of the corresponding ball bearing. The thrust capacity of the bearing is substantial, making it well adapted to the carrying of combined loads.

The question of lubrication is very similar to that incurred with ball bearings under similar load and speed conditions. Oil is considered preferable, but grease may be used where conditions of design require. The saving in amount of lubricant required as compared with plain bearings is precisely the same as with ball bearings.

The housing construction and the provision of suitable seals to exclude dirt and water from the bearings is the same as in the standard practice with ball and roller bearings.

The spherical roller bearing was originally developed and applied in Sweden. Since that time bearings have been installed in the United States, England, France and a number of other countries. The installations that are in service have shown conclusively that this bearing meets an imperative need and is well adapted to the requirements of heavy duty service.

The self-contained and self-alining feature of the spherical roller bearing, together with its exceptionally low coefficient of friction and rugged load carrying capacity, characterizes it as a distinct advance in the development of anti-friction bearing. It offers possibilities that conform with the progressive principles of modern engineering practice.

Kiln Drying of Lumber*

By F. O. Farey

Chief Chemist, Robert W. Hunt Company, Montreal

THE types of kiln in most general use are the compartment kiln for uniformly drying a complete charge, in which the circulation of air is up in the center and down and out at the sides, and the progressive kiln, in which the movement of the lumber and the circulation of air is from one end to the other.

Operation of Kilns

The results obtained depend on the ability, judgment and care of the operator. One of the essential points is the way lumber is piled. Proper utilization of available space and proper circulation of air are essential. You must not pile lumber in a progressive kiln the same as in a compartment kiln. For the compartment kiln lumber must be piled endwise so that the stickers will not obstruct the circulation and form cool pockets. If this passage is obstructed the lumber at these points will dry more slowly and you will have a variable product, not only in moisture content but in checking, internal stresses, and warping, both in and after removal from the kiln. The natural passage of the air is originally vertical between the piles and then laterally between the boards to the sides and vent holes. If stickers block this passage it is almost impossible to get a circulation between the boards. For the progressive kiln, conditions are reversed. Cross piling is also essential so that the stickers will not obstruct the passage of air as it progresses from one end of the kiln to the other. An example is given of two piles in the same kiln having vertical-lateral circulation. On the eighth day when the temperature should have been fairly uniform the thermometer readings were as follows:

	Cross piled lumber	End piled lumber
Center of pile	100 deg. F.	142 deg. F.
Underneath	168 deg. F.	152 deg. F.
Above	146 deg. F.	146 deg. F.

The difference in temperature between the center and bottom of cross piled lumber was 58 deg. F., while the difference in end piled lumber was 10 deg. F. The end piled stock dried in 10 days from 30 per cent moisture to 6 per cent, while the cross piled stock took 13 days to dry from 30 per cent to 12 per cent. In a kiln with end to end circulation the reverse conditions would have been true. It is obvious that lumber should be piled to suit the circulation of the kiln with a view to give the best passage of air through the pile and maintain all parts at as nearly the same temperature as possible. This can only be done by using judgment and carrying on such experiments as will prove or disprove the correctness of that judgment. Not only must consideration be given to the direction of piling and placement of the stickers, but the size of each pile and the thickness of the stickers. Stickers should not be less than 1 in. thick and increased to not less than 2 in. when the thickness of the lumber is 3 in. or greater.

Test Apparatus

The best method of testing the circulation of air in a kiln is to make some kind of smoke cloud. The Forest Products Laboratories at Madison have devised a chemical smoke which eliminates fire risk and which follows the natural air currents with no tendency of its own to rise or fall, which is the objection to some other smoke clouds.

While the smoke cloud is a valuable means of determining circulation, it is not all that we are required to know about what is going on in the kiln. We must, at all times, know the temperature and humidities not only at each end, but inside and near the lumber piles themselves. This requires the use of thermometers and hygrometers of various types. Probably the best of these are the glass thermometers and the wet and dry bulb hygrometers. It is, however, difficult to use them, since no one would care to enter a dry kiln two or three times a day when some of the higher temperatures are reached. This can be overcome by the use of recording thermometers and hygrometers. The recording instruments must be continually checked against wet and dry bulb glass instruments of known accuracy.

No operator should hesitate to ask for necessary instruments, which will enlarge or facilitate his knowledge of what is going on in the drying chamber, and then to ask for such means as may be necessary for the rectification of unsatisfactory conditions. It may cost a few dollars to properly equip a kiln, but any management which takes unnecessary chances with thousands of dollars' worth of lumber is exercising a short-sighted policy.

Drying Schedules

The question is continually asked as to the proper drying schedule for a certain kind of lumber, whether one wood is easier to dry than others, what temperatures to use and how can lumber be dried in a shorter period of time. It is easier to dry some kinds of wood than others. Lumber will dry faster in thin sections, since the distance through which moisture must transfuse from the interior is less. Also certain woods, such as many of the so-called soft woods, allow the transfusion to proceed at greater speed. Relative den-

*Abstract of a paper presented before the Canadian Railway Club, January 9, 1923.

sities of the same species, relative proportion of spring and summer wood, also the direction of the grain in the sawed timber affect the time and treatment.

Much depends on the judgment of the operator after he has examined the material. He should know the approximate moisture content. This cannot be determined by feeling. The only reliable way is to cut off a section at least 2 ft. from the end and determine the moisture content by drying and weighing. A cross sectional sample is usually sufficient, but at times it is necessary to know whether the moisture is the same on the inside and outside of the section. Also at times it is necessary to know whether there are internal strains, even though the moisture may be uniform and no surface checks are noticed. These strains are set up in air drying as well as in kiln drying and unless stresses are relieved by steaming you will, in all probability, increase the defects which already existed at the beginning.

The term "steaming" does not necessarily mean filling the chamber with a cloud of steam, which will condense and give a wet surface to the wood, but increasing the relative humidity to 95 or 100 per cent at the kiln temperature.

Even in the same batch of lumber there will be a wide variation. Some will show higher moisture than others, some will show checks and internal stresses, while other portions will be normal. A sufficient number of tests must be made to know the worst condition. The kiln should then be operated to suit the conditions of the poorest lumber. An operator must know how each charge must be handled and how good he wishes the product. You would not treat rough lumber for some construction with the same respect as you would lumber for furniture.

When the original condition is known the operator must then decide what treatment must be given. It is not possible to give hard and fast schedules for any given lumber. A quite extensive series of schedules, however, have been worked out by the Forest Products Laboratories at Madison, Wisconsin, and given in Technical Note, No. 175, under the heading of hard wood and soft wood drying schedules. This is valuable as a guide since one is often called upon to treat wood different from the kind usually handled. Differences in equipment and the way in which the wood responds to treatment will tell the experienced operator how and when these schedules may be modified.

Without giving these methods in detail, it may be stated that the treatment of soft wood is divided into three general schedules, each modified into three or four subdivisions depending on the kind of wood and the thickness of the sections and original moisture. The initial temperature for the most severe treatment varies from 180 to 200 deg. F., and a relative humidity from 85 to 30 per cent, depending on the original moisture content, down to the mildest treatment having an initial temperature of 135 deg. F. and 85 per cent humidity. The temperature is raised in this schedule to 175 deg. F. and the humidity is lowered to 30 per cent as drying progresses. The hard wood schedules are divided into eight divisions. The most severe treatment compares closely with the mildest soft wood treatment for basswood and birch up to 1½ in. thickness down to the mildest treatment where the initial temperature of 105 deg. F. and relative humidity 85 per cent and a final temperature of 135 deg. F. and a relative humidity of 40 per cent as drying progresses, the latter schedule being applied for certain Southern lowland oaks of 1½ in. thickness.

From green timber with high moisture content down to a content of about 25 to 30 per cent, based on oven dry weight, the greatest care is required. This is what is known as the fiber saturation point. Above this, water exists in the cells in a free condition and must be eliminated slowly and uniformly. Below this percentage the water is combined with the fibers, and drying usually may be somewhat hastened.

No shrinkage occurs above the fiber saturation point, water being evaporated from the outside sections without change in volume. As soon as there is a difference in water content a gradual transfusion takes place from the inner sections. This proceeds until the outside fibers contain moisture below the fiber saturation. Then shrinkage starts around the outer portions but does not yet start in the inside. Thus you have an outside area trying to reduce its volume, but prevented by a resistant interior. One of two things is bound to happen when this condition exists, either the tension will become so great on the outer fibers that they are no longer able to stand the strain, and the wood starts to check or these outer fibers will take a set in an expanded condition, allow the passage of water from the interior to pass through them and finally completely dry out themselves without taking their normal shrinkage. The interior sections as they lose their moisture below the fiber saturation point tend to shrink. Here there are two opposing forces at work. The innermost zones still have their original volume and are under pressure and the intermediate zone is in tension as occurred in the outer fibers originally. One of three things may now happen. If the outer fibers had started to check, the probabilities are that the intermediate section will check in the same place, since at that point there is no fibrous bond between the intermediate and outer zones. If the surface had set in an expanded condition one of two things may happen. The fibrous bond with the outer portion may be sufficient to hold the interior to the same volume and the whole section dry and set in an expanded condition. This may or may not be given the term "case-hardened." If the fibers of every zone have set uniformly throughout it is not called "case hardening" but simply a set in an expanded condition. If, however, the setting or shrinkage has not been uniform when the moisture content throughout the section is the same, and there are set stresses existing throughout the different zones, the condition is called "case-hardening." If these internal stresses exist to a sufficient extent due to internal shrinkage, and the fibers are not strong enough to withstand the tension put upon them, either the annular rings will separate, producing "shakes" or checking will proceed radially, giving a honeycombed condition.

There is no visible means of detecting wood set in an expanded condition, but after the lumber has been taken from the kiln and the fibers begin to take up moisture from the air, the set and set stresses are relieved at first on the outside, setting up other stresses of a reverse nature. These outer zones are now in a condition to shrink in their normal course when allowed to dry again. This will cause checking and warping. If, however, the lumber which has set in an expanded condition is allowed to pick up moisture throughout the whole section all set and set stresses are relieved and the whole board or timber will be in a condition to shrink normally, as it would have done if the drying had been properly carried out. One is thus liable to have a large shrinkage in a section when the moisture content was relatively low as it came from the kiln.

The moisture content is not a criterion of future shrinkage, nor is the shrinkage obtained in the usual tests made immediately upon removal from the kiln a direct index of the shrinkage which may occur when the lumber is put into service.

In the drying schedules suggested by the research work at Madison, the initial humidities range from 80 to 85 per cent, which, at the usual temperatures, gives a condition which will prevent the outside fibers from drying below 15 to 20 per cent. In view of the fact that moisture is being transfused from the interior, the moisture in the outside areas is maintained at or about the point at which shrinkage occurs and the speed of the evaporation for different woods is regulated by the temperature. As the 25 per cent saturation point is approached for the entire stock, the outside areas dry further and begin to shrink. Here is where trouble is liable to occur, either from checking or case-hardening. Here the contents of the kiln must be watched to observe how the wood

is reacting, and it is desirable to remove samples and test as described later.

At the sign of checking, hollowing, or pinching of surfaces or internal stresses as determined by test, measures must be taken to counteract the action. Surface areas must be allowed to take up moisture to relieve strains by increasing the atmospheric humidity. Introduction of steam in sufficient quantities is the usual method, and where the moisture content of the wood is relatively high, say around 15 per cent, humidity is increased to 100 per cent from one-half hour to several hours, depending on the extent of the trouble. Not more than six hours for each inch thickness of timber is practically certain to relieve the most severe conditions. Temperature is often raised 20 to 30 deg. during the steaming and, if so, care should be taken to allow the kiln and stock to cool to the drying temperature before materially lowering the general humidity.

Steaming should be resorted to any time danger appears and may be required several times during the period of drying. It also raises the temperature of the interior of the timber, thus allowing a more rapid transfusion of moisture, but unnecessary steaming or over steaming may do more damage than good by working the wood and slowing the process.

Timber should be examined before it goes into the kiln, not only for moisture content, but for checking and casehardening conditions when received. In this case steaming is the only remedy to relieve initial stresses. Also mouldy conditions may exist or mould may develop in the kiln under low temperature and high humidities. This mould may be killed by steaming at 170 to 180 deg. F., for not more than an hour and maintaining a 100 per cent humidity with live steam. The quicker the temperature is brought up the better, as it is not desirable to heat the interior of the timber more than necessary, and it is essential for the kiln to cool to drying temperatures in nearly saturated atmosphere.

Some steaming may be resorted to at the end of the drying process, especially if tests show that there are stresses existing and interior moisture above 7 per cent.

In all steaming or conditioning processes the kiln and lumber must be cooled to operating temperatures and humidity conditions high enough to prevent drying must be maintained during cooling.

A reduction of time of drying can only be accomplished by vigilance and an exact knowledge of all conditions, at all times.

A superheated steam process which will dry lumber from the green state to 10 per cent moisture in 24 hours or less has been worked out at Madison for some lumber, such as firs, Western hemlock, Western and Southern yellow pine. This is carried on by forcing superheated steam at high velocity in alternate directions through the kiln. This consumes more steam than the older process and temperatures must not be maintained for more than two or three days. The writer has been asked if any special processes had been developed for drying oak timbers. There are schedules for oak up to 2 in., or 3 in. in thickness, and there is no reason to doubt that much larger sections could be treated with equipment where all conditions of temperature and humidity are under perfect control. However, some types of oak are very difficult to handle, and it depends on whether the results obtained are worth the possible loss, time, trouble and cost of treating this timber.

There have been questions as to whether the kiln dried lumber is equal to air seasoned lumber. Lumber in general is just as good if properly kiln dried as if air seasoned; it should be better, because in the kiln all factors can be kept under control, whereas in air the temperature and relative humidity are beyond control and may vary decidedly from time to time.

There is a feature in connection with kiln drying in which most of you are more or less directly interested—to what extent should the drying process be carried and what moisture should be left in the wood when used for various purposes?

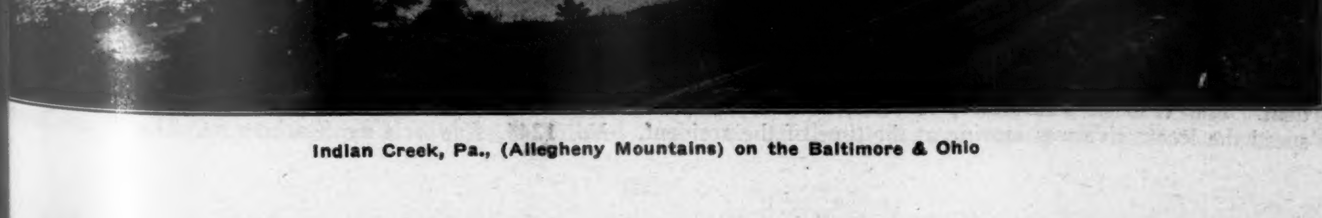
The final moisture content of wood is a function of the temperature and the relative humidity of the atmosphere to which it is exposed. If too wet it will dry out and shrink. If too dry it will take up moisture and expand. The relative humidity has far more effect than the temperature, but this is often affected by a change in temperature.

All moisture results should be based on percentage of water to the basis of the dried samples, and not as it is often calculated on the basis of the sample received. This practice has been adopted by technical experts and will undoubtedly come into universal practice. For instance, a sample weighing 6 lb. dries to 4 lb. Instead of dividing the loss by six it is divided by four (the dry weight) giving 50 per cent moisture.

Since no data of the moisture content of lumber taken from cars or old buildings, seemed to be available, numerous samples were taken from different parts of cars under repair at Montreal, and samples of wood which had been stored in heated buildings. The results obtained should not be considered as conclusive for other places, or periods, but are given as an idea of what experimental work should be undertaken by individuals interested in wood construction.

That they may be better understood, these results are reported both on the basis of the samples as received and on the oven dry weight:

	Per cent moisture on basis of original sample			Per cent moisture on basis of dry sample		
	Max.	Min.	Av.	Max.	Min.	Av.
Car sheathing and lining	12.8	9.8	10.7	14.6	10.9	12.0
Decking (car)	18.3	11.0	13.8	22.4	12.2	16.1
Roofing (car)	28.7	9.6	18.9	40.6	10.5	24.3
Car frame timbers	14.0	10.0	11.9	16.6	11.0	13.5
Wood stored in heated building	6.7	5.4	6.2	7.2	5.8	6.6



Indian Creek, Pa., (Allegheny Mountains) on the Baltimore & Ohio

Recent Decisions of the Arbitration Committee

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Responsibility for Per Diem When Repairs Do Not Conform to Rule 120

Under date of September 22, 1920, the Pittsburgh, Shawmut & Northern submitted an inspection report and asked for disposition of the Seaboard Air Line steel hopper car No. 30344, under Rule 120. The cost of repairs shown on the inspection report was $500 labor and $550 material. The owner authorized repairs according to original construction, on October 12, 1920, and the car was returned to service on December 1, 1920. On May 7, 1921, however, the car was received on the Seaboard Air Line and an inspection developed the fact that the repairs authorized as shown on the inspection certificate had not been made. The bill rendered by the Pittsburgh, Shawmut & Northern covered a total cost of repairs, including both labor and material, of $176.83. Inasmuch as the minimum expenditure for labor to bring the car under the provisions of Rule 120 is $180, the owner contends that the Pittsburgh, Shawmut & Northern should make settlement for the per diem according to paragraph b, Rule 8, of the per diem rules. The Pittsburgh, Shawmut & Northern considered that it was proper to report the car under Rule 120 and that dismantling would have been the proper disposition. To this, however, the owner would not agree. The Pittsburgh, Shawmut & Northern was not equipped to rebuild the car and contends that it should not be penalized for per diem while waiting for disposition from the owner or because of its inability to make the heavy repairs required under Rule 120.

The decision of the committee confirms the contention of the owner that inasmuch as the labor cost of repairs was less than the limit prescribed in Rule 120 and partial repairs were not authorized, the car as repaired would not be subject to Rule 120.—*Case No. 1237, Seaboard Air Line vs. Pittsburgh, Shawmut & Northern.*

Handling Line Responsible for Damage Caused by Lack of Precaution in Coupling to Train

On January 8, 1922, the underframe of Central of Georgia box car No. 26132 was broken in two over the transom and the car otherwise damaged, in a Wabash freight train while the locomotive was coupling onto the train. In setting out this car, which was the seventh from the locomotive, a main line frog was damaged. No other cars in the train were damaged and it proceeded after setting out the Central of Georgia car. The car was reported by the owner to be 14½ years old. The Wabash requested disposition under Rule 120, claiming that the car was not derailed, cornered or side-swiped at the time of the accident. In complying with the request of the owner for information concerning the circumstances surrounding the damage, photographs were submitted which indicated that the car had been derailed, one of the trucks knocked off center and placed inside the car. The Central of Georgia therefore refused settlement under Rule 120. The photographs, the Wabash contends, show the condition of the car on a siding several months after the accident. The Wabash was unable to state, however, at what speed the locomotive was moving at the time of the accident, but maintained that it was moving slowly. The engine was reported to be moving backwards without signal, the head brakeman catching the front end of the locomotive and riding with it until the accident occurred.

The following decision was rendered by the Arbitration Committee: "The evidence is not conclusive that one end of the car was down on rail or ground as a result of the impact.

"It is evident, however, that in backing up with locomotive, there was no one in position to give proper signal. Therefore, handling line is responsible as per Rule 32, section (d), items (2) and (4)."—*Case No.* 1246, *Central of Georgia vs. Wabash.*

Responsibility for Missing Air Hose—Car Not Offered in Interchange

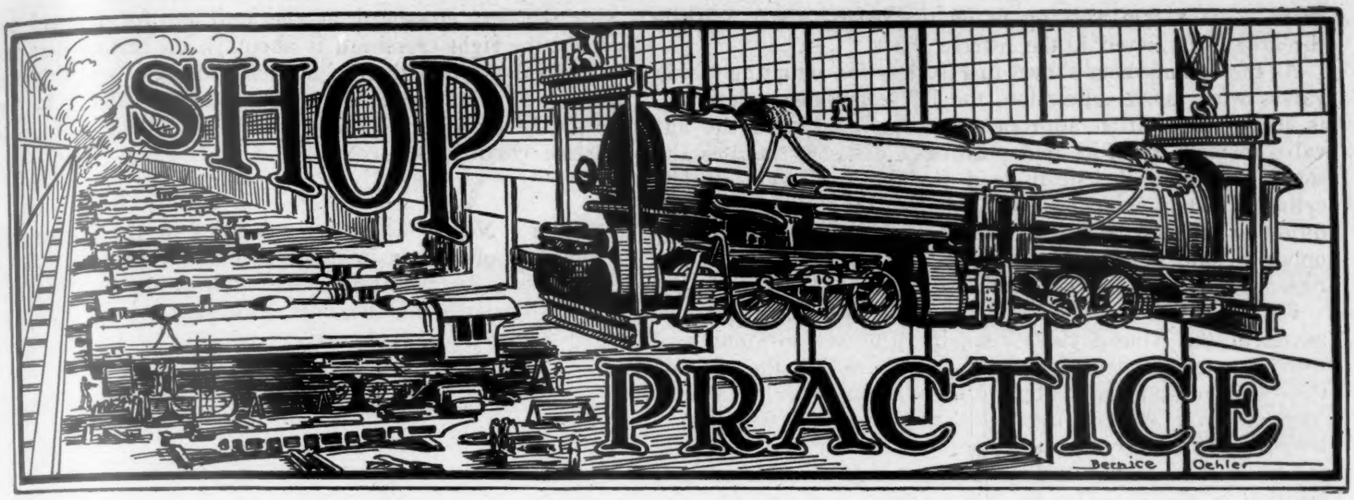
On September 1, 1920, the Chicago Junction replaced a missing air hose and angle cock on Sand Springs Railway car No. 406, billing the owner for $3.25. The owner took exception to the charge, claiming that the hose and angle cock missing is a delivering company responsibility under interchange Rule 58, notwithstanding the fact that repairs were made before the car was delivered in interchange. The hose and angle cock were lost or stolen between the time the car was received by the Chicago Junction and placed for loading at an industry on its line and when it was received loaded from the industry in the transportation yard. The repairs were then made and the car delivered to the Atchison, Topeka & Santa Fe. The Chicago Junction contends that there is no record of the hose and angle cock being stolen while the car was in its possession, that it was not delivered in interchange with these parts missing, and that under Rule 43, the owner is responsible.

The Arbitration Committee decision states that: "The car was not interchanged with the air hose and angle cock missing; therefore, Rule 58 does not apply. The car owner is responsible under Rule 43."—*Case No.* 1240, *Chicago Junction vs. Sand Springs Railway.*

Repair Card the Basis of Decision in Claim for Wrong Repairs

On November 14, 1920, at its shops at Port Arthur, Tex., the Texas Company obtained joint evidence showing that the A end of its car T.C.X. No. 1261 was equipped with a Sharon coupler having a 5-in. by 5-in. shank with a 6½-in. butt. The Texas Company maintained that the car was equipped at both ends with standard 5-in. by 7-in. by 6½-in. couplers when the car left Port Neches on October 14 for a trip during which it moved only over the lines of the Kansas City Southern and the St. Louis-San Francisco. During this trip, on October 22, 1920, the Kansas City Southern made repairs and billed for the replacement of a broken coupler yoke and cast steel carrier iron. The St. Louis-San Francisco made no repairs to the car during this trip. The Texas Company maintained that the standard coupler must have been replaced with one having the smaller shank when these repairs were made on the Kansas City Southern, and in support of this view called attention to the common practice of replacing a coupler removed from a car with another to which a yoke had already been riveted. The Kansas City Southern maintained that at the point where the repairs were made it has a blacksmith and that the new yoke was applied to the coupler which was removed from the car and that therefore it was not responsible for wrong repairs.

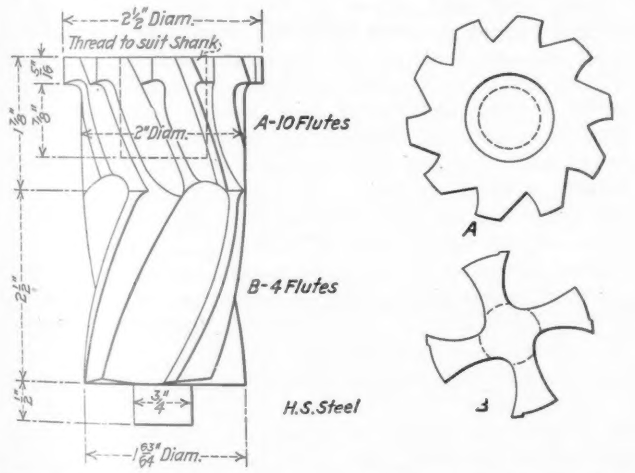
The Arbitration Committee decided that: "The billing repair card of the Kansas City Southern does not show the coupler to have been applied; therefore the Kansas City Southern is not responsible. Case 1208 is parallel."—*Case No.* 1244, *Kansas City Southern vs. The Texas Company.*



Cutting and Reaming Boiler Tube Sheet Holes

By George Bexton
Tool Foreman, Grand Trunk Shops, Stratford, Ont.

For rapid and smooth cutting of boiler tube sheet holes, the combination cutter and reamer illustrated has been found very satisfactory. It reduces costs and speeds up the work. Previous to the development of this tool cutting was done in two operations. All the tube holes were cut



Combination Cutter and Reamer Saves Time on Tube Sheet Holes

out to within 1/64 in. of the size required, by a tool similar to the cutter illustrated at *B*. Then the tool was changed to a reamer similar to *A*. This made it necessary to set each hole twice, whereas by combining *A* and *B* in one tool the job could be done in one operation. Cutter *B* is fed by the machine until it has cut through the plate, the feed being released and reamer *A* finishing the job, being fed by hand since this is quicker than machine feed.

The tool, illustrated, is made of Double Mushet high-speed steel. Cutting section *B* has 4 flutes with a spiral of 1 in. in 12 in. right-hand, giving the cutter a rapid cutting action. The reaming section *A* is cut 10 flutes, left-hand spiral to prevent the reamer from seizing and leaving a rough hole. The reamer has a recess ¼ in. wide and 1/16 in. deep between *A* and *B* to allow any cuttings to escape from the cutting section. Section *A* has a taper of 3 in. in 12 in. for a distance of 7/16 in. and then paralleled cutting edges ⅞ in. long to finish the hole to the correct size. A round filleted shoulder at the top removes the sharp edges of the tube sheet holes and prevents the copper ferrules from being cut in the process of beading or expanding. The tool is detachable from its spindle which is turned down to 1 1/16 in. in diameter and threaded 12 threads per inch. This threaded end of the spindle turns into the threaded cavity in the cutter. The use of a heavy oil on the threads enables cutters to be readily removed so that the operator may use any number of cutters on one spindle. The spindle is made with a No. 5 Morse taper shank.

Angularities in Young Valve Gear

By Harry Cornell
Louisville, Ky.

The difference in the elevation of the center lines of cylinders and driving wheels introduces a unique and interesting angularity in the Young valve gear, as the following resume of the gear shows. Referring to Fig. 1, the gear is shown with the link blocks in mid position, the left crosshead pin P_1 being at the forward extremity of its travel while the right crosshead pin P is a little distance back of the mid

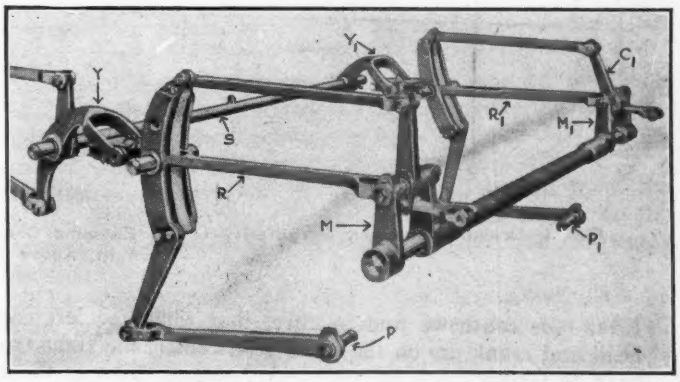


Fig. 1—Young Locomotive Valve Gear with Link Blocks in Mid Position

point of its travel due to the oblique position of the right main rod.

As Fig. 1 represents a gear for a locomotive wherein the right crank leads the left crank 90 deg., assuming the cranks to be moving clockwise, the back end of the right radius rod R is positioned above the center of oscillation of the right link while the back end of the left radius rod R_1 is below the center of oscillation of the left link, and these relative positions of the radius rods are possible because the bell

crank Y is a free working fit on the reverse shaft S while the arm Y_1 is keyed to the reverse shaft.

As the arrangement shown in Fig. 1 is for actuating piston valves with inside admission, the left combination lever C_1 is shown in position appropriate to having caused the left valve to move from its mid position a distance equal to the steam lap, plus the steam lead for the front port of left cylinder. It is evident that the motion of one valve in addition to lap and lead is derived from the crosshead on the opposite side of the engine through the medium of two rockers, M and M_1, keyed to the same shaft.

Fig. 2, which shows in skeleton form the constituent elements of the Young valve gear in different positions and which was constructed on the assumption that the axis of the cylinder and the center of the driving wheel are at a common level, shows three positions V of the combination lever; the full heavy line for front dead center, the dash line for back dead center, and at the light full line for neutral position of the valve. (In Fig. 2, those parts of the gear found on the right side of the engine are indicated by heavy lines while the light lines indicate those on the left side.) The union link, indicated in three positions as 111, is of a length equal to the distance FG and is common to the two sides of the engine when the centers of the cylinder and driving wheel are at the same level.

On American locomotives, as a rule, the cylinder center line is higher than the center line of the driving wheels, frequently as much as 4 in. The distance, indicated in Fig. 2 as main rod error, is not, therefore, the same on the two sides of the locomotive. The union link, designated as 111 in Fig. 2, has a greater length on the left side than on the right for the reason that with the engine moving ahead, the crank moves through less than 180 deg. as the piston and crosshead move from the front dead center to the back dead center and more than 180 deg. as the piston and crosshead move from the back dead center to the front dead center. with the left crosshead at the position for forward dead center, the right crosshead is about ⅛ in. further back from its central position than is the left crosshead when the right crosshead is at position for back dead center. In other words the error in crosshead position is about ⅛ in. under extreme conditions.

* * *

Editor's Note.—These irregularities in the Young valve gear, while of interest in connection with valve setting, are so slight as to be practically negligible, according to O. W. Young, designer of the gear, provided wheel centers are taken as directed. These directions provide for taking each

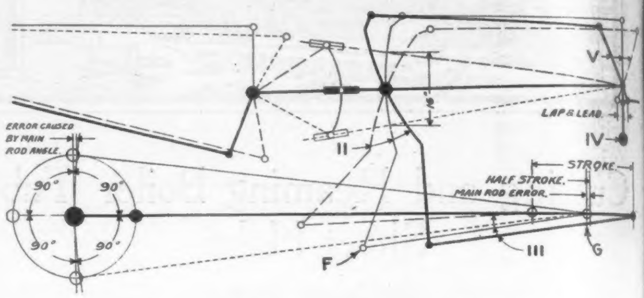


Fig. 2—Diagram in Which Heavy Lines Show Right, and Light Lines Left, Side of Young Valve Gear

wheel center by locating the opposite crosshead the specified amount (dependent on main rod angularity) back of mid stroke. Concerning this subject, Mr. Young has the following to say: "If, as is usual, the center line of the cylinders is somewhat higher than the center line of driving axles, and dead centers are taken on the wheels, as is customary, then in order to obtain absolutely constant lead for all cut-offs, forward and backward motions, the union link

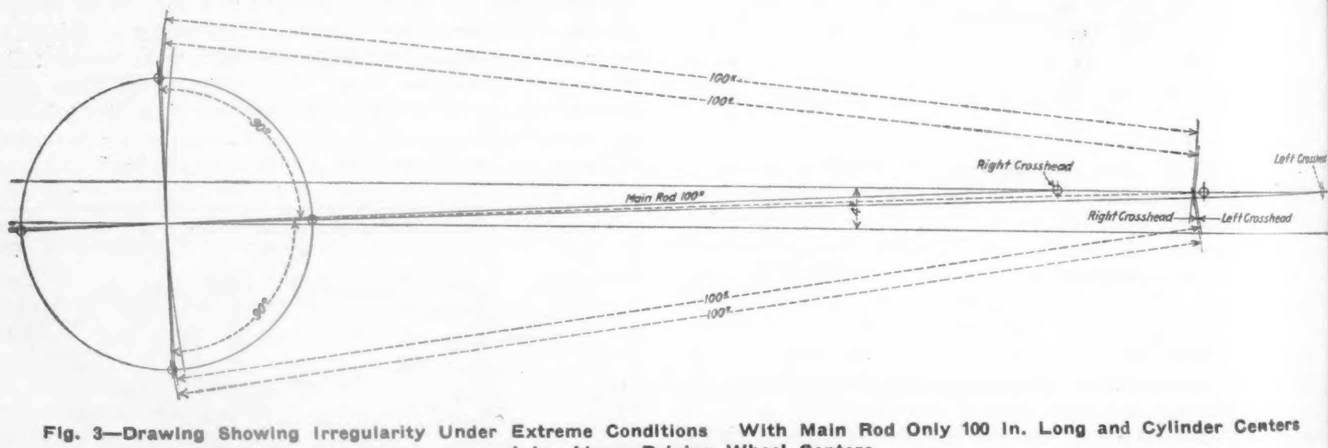


Fig. 3—Drawing Showing Irregularity Under Extreme Conditions With Main Rod Only 100 In. Long and Cylinder Centers 4 In. Above Driving Wheel Centers

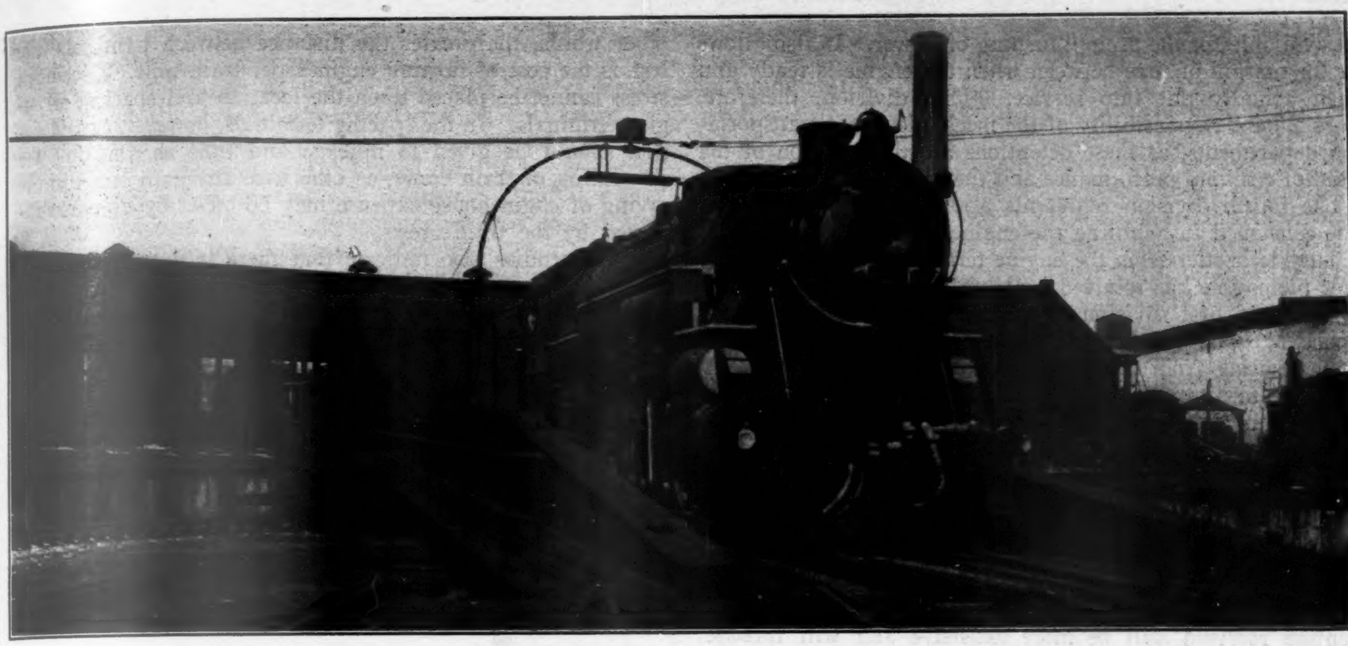
From this cause we find in effect that when the left crosshead and crank are on the front dead center, the right crosshead is farther back of mid-stroke position than is the left crosshead when the right crosshead is on the back dead center.

This simply means that the distance from F, which indicates the foot of the link with the latter in central position, to G, the position of the crosshead pin, is greater on the left side of the engine than on the right side. Consequently, we must assign to the two union links two different proportions; i.e., assign to the left union link a greater length than to the right union link.

The crank and crosshead diagram, illustrated in Fig. 3, is furnished by the courtesy of O. W. Young and will aid in visualizing the facts mentioned in the immediately preceding paragraphs. Referring to Fig. 3 it should be noted that would need to be of different lengths for front and back dead centers, which is a mechanical impossibility.

"If the center line of cylinders were 8 in. or 10 in. higher than the center line of driving axles, it would be difficult to so proportion the union links as to produce symmetrical valve movement, particularly in lead openings, but because the cylinder center line is usually only from 1 in. to 3 in. higher than the center line of driving axles, the union link can be adjusted for length to suit either front or back dead wheel center, without causing an appreciable error in valve movement beyond slight irregularity in lead at one port.

"If the union link length is determined by taking wheel centers according to directions, errors in lead are too slight to be measurable unless the differences in height between center lines of cylinders and driving axles exceed 4 in."



Electrical Turntable Drive, Insures Ample Power and Reliability

A Mechanical Man's Views on Engine Terminal Design and Operation*

By L. K. Silcox

General Superintendent of Motive Power, Chicago, Milwaukee & St. Paul, Chicago

FROM the statistics compiled for all railroads in the United States, it has been determined that in every 24 hours, the average serviceable locomotive is used a little less than 8 hours in actual road service. This figure gives no consideration to the fact that the average annual locomotive service days range from 300 to 330 days out of the 365 days of the year, or only about 80 per cent. Therefore, of the total complement of locomotives owned, approximately 80 per cent are serviceable throughout the year and of the 80 per cent serviceable, only 33⅓ per cent of the actual hours in service are utilized so that the net amount of service obtained is only approximately 28 per cent of the total.

Therefore, since the engine is in service an average of only eight hours out of each 24, the inference is that the remaining 16 hours are consumed at the terminals in conditioning the engine for another trip and holding it awaiting call. It would appear that these 16 hours represent a tremendous waste of time and that earnest endeavor should be made to recover it for revenue service. However, consideration should be given to the fact that a certain amount of this time is absolutely necessary to prepare the engine for service.

Four Operations to Be Considered

The circular chart shows the distribution of the 24 hours of the average serviceable locomotive day. From reports of enginehouse performance, it has been determined that the average serviceable locomotive is turned approximately 1.4 times in every 24 hours from which information, it can be assumed that the average time required to turn an engine is about 11½ hours. For this reason the 16 hours of terminal detentions have been divided on the chart and 11½ hours indicated as representing one complete engine turning with the remaining 4½ hours considered as a portion of the next turning. An analysis of the various operations constituting an engine turning in the usual sequence of their occurrence indicates a grouping into four main divisions. These divisions, with the average approximate time element of each, are as follows:

Movement of the engine from the train to the engine terminal	¾ hour
Roundhouse care and ordinary repairs	8 hours
Extraordinary repairs and awaiting call	2 hours
Movement from outbound track to train	¾ hour

The first division represents the time consumed in releasing the engine from road service and in delivering it to the engine terminal, or in other words, what is usually termed outside hostling. The time element of this division is a function of the terminal layout and will depend upon the relative location of the engine terminal with respect to the train yard and the track arrangement leading into the engine terminal.

The several operations constituting the second division, when taken in their usual sequence average approximately as follows:

A.—Removing supplies, outside inspection, and knocking fires	1 hour
B.—Movement from cinder pit into roundhouse stall	¼ hour
C.—Inspecting, repairing, cooling down, and washing boilers and tanks	2½ hours
D.—Wiping, completing repairs and filling boilers	2½ hours
E.—Building fires and steaming up	1 hour
F.—Movement from roundhouse to outbound track, taking coal, water, sand, and supplies en route	¾ hour
Total	8 hours

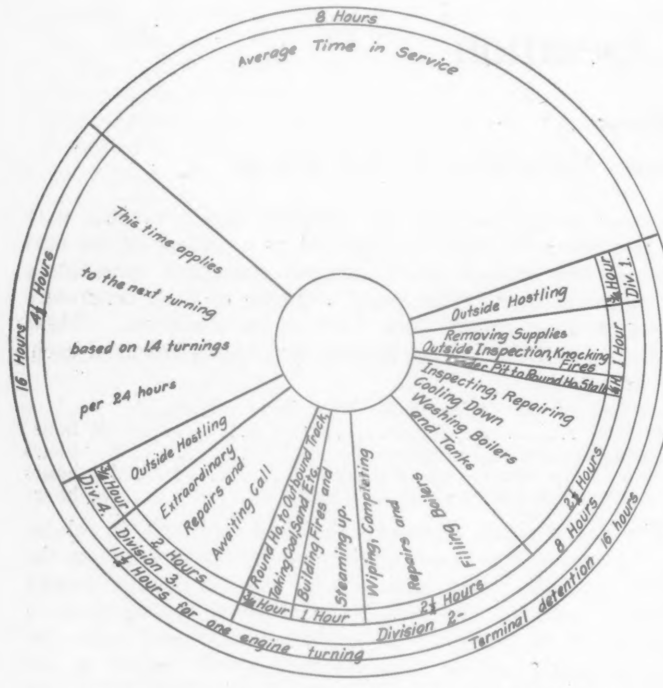
The third division is necessary to provide a period for overlapping to take care of extra repairs and to compensate for slow operations at points where sufficient facilities are

*From a paper presented March 13, 1923, before the Western Society of Engineers, Chicago, Ill.

not available for the prompt turning of power. It also allows for the margin of time between when the engine is ready and when actually put into service. This division, therefore, bears a joint responsibility of the mechanical and transportation departments, as these detentions are the function of the speed of terminal performance and the utilization of power.

The fourth division represents approximately the average time consumed in handling the engine by the engine crew or an outside hostler from the engine terminal to the train yard after the engine has received coal, water, sand, and supplies. As with the first division, the time element of this is also dependent upon the location of the terminal and the track layout leading from the terminal to the yard.

Thus a medium of measure is established for comparison. However, it cannot be applied literally, for it represents a collective result and should be made by grouping terminals either by divisions or districts. This becomes apparent when considering supplementary roundhouses where no machine shop facilities are available as against the major terminal which is well-equipped for making heavy repairs. The former merely constitutes a turn around point where the engine is turned and provisioned, while at the latter, the attention received will be more extensive and will include repairs so that it would not be fair to compare the one with the other merely on the time element basis. The combined result of the two, however, could be compared equitably with the results as indicated on the chart.



Distribution of the 24 Hours of the Day for the Average Serviceable Locomotive

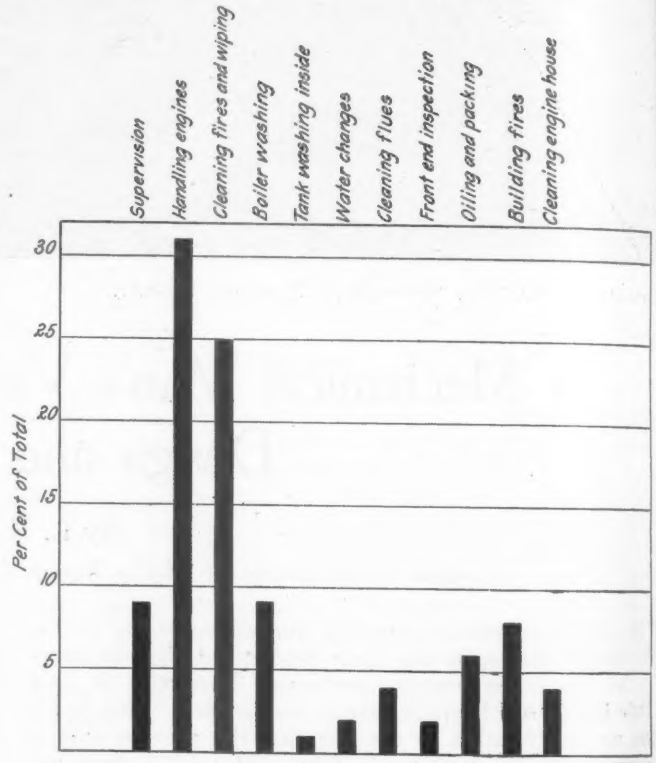
There are four fundamental factors relating to the proportion of time in service and out of service:

1. Mileage and time between terminals.
2. Demand for power.
3. Terminal layout and the location with relation to the train yard.
4. Facilities for conditioning engines for service.

Length of Engine District a Factor

From observations made of the performance on various railroads, especially when making a study of enginehouse expense, it appears that there are various basic elements which affect such performance, among which can be considered the average miles between engine terminals. A study of eight carriers reveals that the average distance between terminals ranges from 57 to 114 miles. It is found that each cost varies inversely with the miles between the terminals. In other words, the greater the distance between terminals, the less is the cost of turning engines per train mile. Too much stress cannot be placed upon the location and spacing of engine terminals. In the spacing terminals, however, consideration should be given to mileage and time as affecting the scheduling of train crews, as otherwise any gain made in the saving of enginehouse expense may be offset by overtime incurred by the train crews.

These studies also indicate that there is a great variation in the frequency of turning engines. This depends upon the distribution of power according to the demand, the amount of power owned in proportion to the volume of traffic, and



Relative Labor Costs of Various Operations in Engine House Expense

most important of all, the frequency of terminals. When there is a large number of power units, but a great frequency of terminals, short runs will prevail, whereas if the runs are longer the number of service hours per day will increase, the dead time at terminals will be reduced, and the gross ton miles will increase with a consequent increase of earning power per locomotive. The spacing of terminals has an effect on the serviceable hours per day, but this should not imply an advocacy of unnecessarily long runs or the skipping of terminals, but rather the providing of a rearrangement that will give a more uniform distribution of terminals so as to reduce the amount of terminal handling to a minimum consistent with the volume of traffic.

The question of margin of power is also very vital and must be considered before any step is taken at any one terminal to improve it out of proportion to the neighboring terminals. As an illustration, there may be an engine terminal where there are from 20 to 22 engines in the house at all times with an average of only eight departures and eight arrivals in the 24-hour period. In such a case, the dead time proportion of the 24 hours would be very large and would require a relatively small force to operate the terminal and possibly permit the use of two instead of three shifts. On the other hand, there may be an engine terminal with only 12 engines in the house at all times and with an average of 10 arrivals and 10 departures every 24 hours. Here operation would be more intensive, requiring a relatively large force, possibly three shifts, and with facilities which

would permit the turning of power in less than 8 hours so as to be in a position to overcome any emergency.

The relative location of the terminal with respect to the yard and depot is a factor affecting Divisions 1 and 4 of the chart. If the terminal is close so that the engine may be uncoupled from the train and delivered directly to the engine terminal, only a few minutes will be involved, but if it is a long distance away or the movement involves complicated switching, the time loss becomes a large item.

To the mechanical man, the engine terminal is a facility, or in other words, it is merely a tool with which to perform a specific operation in detail. It is a double-edged tool as there are two functions to perform. The first is the ordinary handling and care of the individual locomotive in the roundhouse, and the other is repairs, both lighter classified and running. In the well-ordered performance of locomotives, it is necessary to divide the maintenance into running and classified repairs. The running repairs must of necessity be made in the roundhouses. It has been the usual practice to do the classified repairs in the back shops, but there is an increasing tendency to do the lighter classified repairs as well as the running repairs in the roundhouses in order to get a more intensive use of the power. It is the custom among some carriers to assign a certain mileage for a locomotive to perform between classified repairs, and in order to operate locomotives at a minimum cost per mile, for all classes of repairs, it is necessary to obtain a consistent balance between the cost of classified repairs and repairs made in the roundhouses. The manner in which roundhouses are equipped with repair facilities determines the balance.

It is the practice on many lines to send locomotives to the back shop only when in need of heavy boiler repairs, taking care of all other work as due in the roundhouses. It is a function of the roundhouse, therefore, to obtain from the locomotive a specified performance in mileage and time, and to see that every engine leaves the terminal in proper condition to insure a successful trip.

Much of the Repair Work Is Done at the Roundhouse

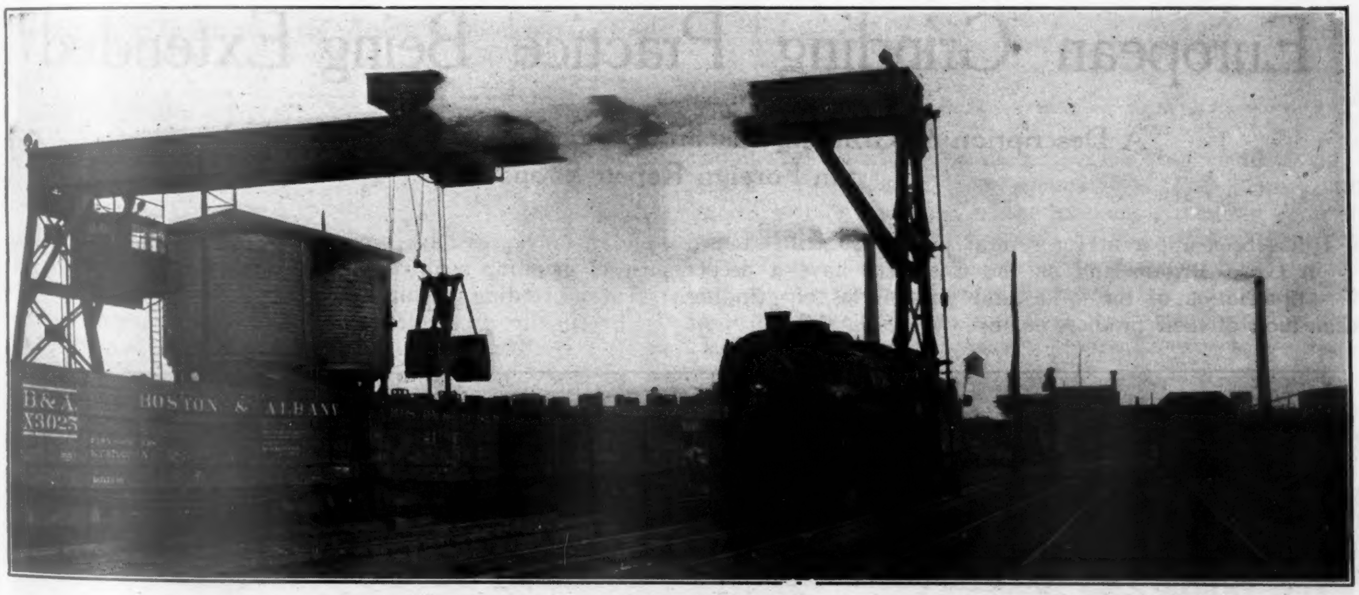
The roundhouses usually perform maintenance work on locomotives to the extent of approximately 40 to 50 per cent of the total cost of repairs and should, therefore, be equipped with this in mind. Any ratio ranging from 60 per cent for classified repairs to 40 per cent for running repairs on the one hand or from 50 per cent for classified repairs to 50 per cent for running repairs on the other hand would seem practical. The ratio between the cost of repairs done in roundhouse and back shop depends largely upon the policy pursued with respect to the amount of work expected from the roundhouses.

As was mentioned at the beginning of this paper, the average locomotive produces annually from 300 to 330 serviceable days out of the 365 days of the year. The opportunity for producing higher efficiency in serviceable days per year obtains from the ability to keep the locomotive within the jurisdiction of the local man and this can best be done by providing him a well-selected supply of standard repair parts and materials, and with ample facilities with which to make prompt replacements and repairs when due, thus eliminating delays occasioned in waiting for parts and materials from the main shops, or in transporting the engine itself to the main shops for repairs.

It is more difficult to maintain the larger units of power that now predominate than it was to care for the smaller engines that were in use in the past. The modern engine is heavier and more complicated, and requires more consistent and frequent mechanical attention. The various parts of the locomotive are larger and heavier and cannot be repaired quickly, if adequate facilities are not at hand with which to handle them. Generally speaking, the increase in the capacity and extent of facilities in roundhouses has not kept pace with the increase in number and size of power units, and until this is brought to a proper balance, it cannot be expected that the full serviceability of the modern power will be attained. A modern locomotive represents a large capital investment and idle hours are of a relatively greater loss than in previous years.

In order to illustrate the general situation on a large railroad system, it is necessary to know just how the various divisions range as to the volume and density of traffic. This forms the knowledge necessary to understand the proper assignment of power to divisions after considering track gradients and curvature, and other operating features. A high performance in car miles per day is not obtained by train speed, but by the promptness with which trains are broken up, assembled, and moved through terminals. A terminal should be prepared to handle without delay any reassignment of power for seasonal loading or other reasons. Improved engine facilities should be made with consideration of the general situation, strengthening the weaker points first and thereby building up to a higher general efficiency.

There is no such thing as an ideal engine terminal, or an ideal terminal operation. From the very poorest to



Modern Ash-Handling Facilities Relieve Congestion at a Prominent New England Terminal

the very best they are a compromise. There are so many circumscribed elements affecting each point that no matter whether it was built up by gradual expansion or is constructed new, the final layout will always reveal some undesirable features. Financial stringency will retard development and restrict new construction. Precedent hampers relocation of existing facilities. A good labor market often overbalances other advantages and designates a location that is geographically or otherwise improper. So we must compromise and use to the best advantage what we have and that which we can obtain.

We are confronted with the problem of not only creating modern terminals in new locations but of overcoming a situation that has developed gradually with the growth of the railway property. Terminals constructed in new locations can easily be equipped with all the proper and modern facilities required for economical and prompt handling of power, but it is more difficult to rearrange existing facilities than to construct new ones and it is this feature of the work which will require the attention of railroad managements for many years to come.

To illustrate the importance of improving engine terminal facilities and relocating them to reduce the time element per engine turned and the frequency of turnings: The average cost of turning power is now approximately $6 to $8 per engine turning and the average number of turns is 1.4 per serviceable locomotive day. A revision of facilities that, by reducing the time element of turning, would produce a reduction of 50 cents per engine turned and reduce the frequency of turning 0.1 turning per day (say from 1.4 to 1.3), will accomplish an annual economy on a complement of 2,000 locomotives to the extent of approximately $650,000, an amount that would pay interest at 5 per cent on $13,000,000. Such an appropriation, properly distributed over the system, would provide for a great many time-saving features which, if utilized advantageously, would produce large returns on the investment and at the same time recover many serviceable locomotive hours to revenue service.

What the mechanical department expects from the locomotive terminal is to derive from it a medium by which locomotives may be cared for and maintained properly, promptly and cheaply, and from which locomotives may be consistently delivered to the transportation department with the result that the serviceable hours per locomotive per day and the serviceable days per locomotive per year may be increased to a maximum.

European Grinding Practice Being Extended

A Description of Grinding Machines and Methods of Proven Value in Foreign Repair Shops

IT has been apparent for several years that railroad men in Great Britain and on the Continent have a deeper appreciation of the value and possibilities of grinding than most of their brothers on this side of the Atlantic. At least this is the unavoidable conclusion of anyone who has studied the number of different grinding operations carried out abroad. In its issue of June 1922 the *Railway Mechanical Engineer* published an article describing certain grinding practices in English railway shops and since that time, important advances have been made both in the more general use of grinding methods and the improvement and development of grinding machines.

Fig. 1—Grinding Car Axle Journals on a 16-in. by 96-in. Churchill Plain Grinder in a Belgian Car Shop

Practically a complete line of grinding machines is now being made, for example, by the Churchill Machine Tool Company, Ltd., London, England. The extent to which these machines have been developed for railroad shop work will be more or less of a surprise to American railroad men, many of whom are accustomed to nothing more advanced than

a piston rod grinder. The following list will give some idea of the work handled on these machines:

Type of Grinding Machine	Locomotive Part Ground
16-in. by 96-in. plain grinder	Axle fits and journals.
Other plain cylindrical grinders	Miscellaneous parts.
Vertical spindle radius and hole grinder	Links and holes.
Car wheel bore grinder	Car wheel bores.
Vertical spindle surface grinder	Guides, rods, etc.
Plain grinder for pins	Motion work pins.
Portable valve bushing grinder	Valve chamber bushings.
Horn cheek grinder	Frame pedestal jaws.
Double vertical spindle grinder	Main and side rods.
Horizontal spindle link grinder	Links and other parts.
Turret head grinder	Miscellaneous grinding.
Internal grinders	Air compressor cylinders.
Horizontal spindle grinder	Misc. surface grinding.
Rotary surface grinder	Packing rings, dies, etc.
Tool room grinder	Shop tools.

In addition, plans are definitely under way and tentative drawings have been made of machines to grind driving axle

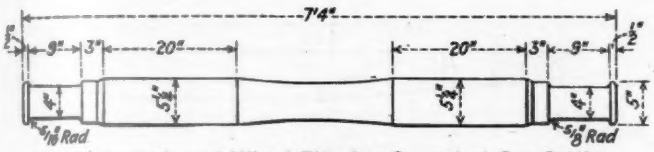


Fig. 2—Journals and Wheel Fits Are Ground at One Setting

journals with the wheels mounted and crank pins also mounted.

While it is realized that some of these machines would require changes in design and especially size to take care of the relatively larger parts of American locomotives, these alterations in many cases would be slight and with standard

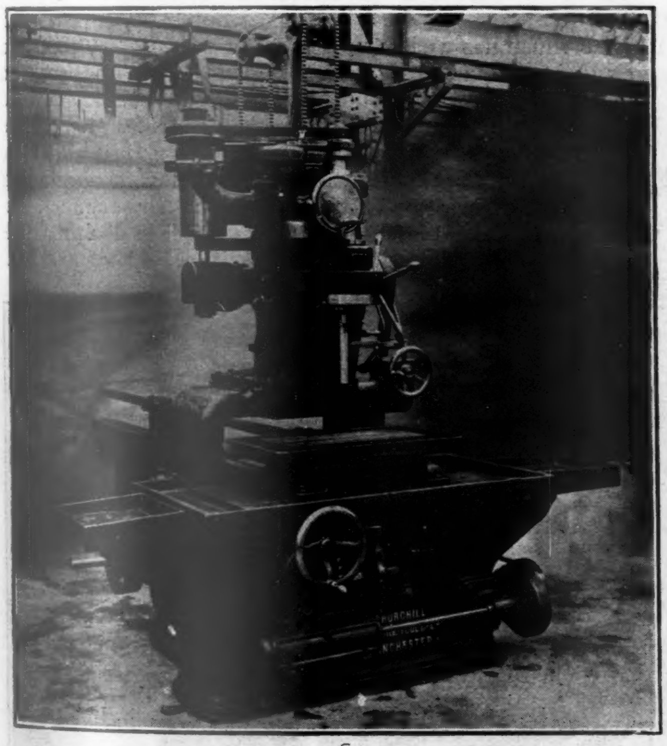


Fig. 3—Vertical Spindle Radius Link and Hole Grinder

machines, such as surface grinders, plain cylindrical grinders, and internal grinders, no alterations would be necessary. The following description of some of the grinding machines and methods used in foreign railway shops is given in the hope that it will lead to a better appreciation of the possibilities of grinding by American railroad shopmen.

Wheel Seats and Journals Ground

The practice of grinding journals has been thoroughly tested out with favorable results as regards accuracy, finish and length of operation. The ground journals give superior service to those finished by other methods and, in addition, only enough material is removed at each grinding to true the journal, thus greatly increasing its effective life before it becomes worn and ground down to the limiting diameter. Fig. 1 illustrates a 16-in. by 96-in. plain grinding machine installed in one of the largest Belgian car shops. This machine is equipped with an axle positioning device provided to take care of the varied depths of center holes in the ends of the axles, it being essential that all axle journal center distances be maintained a standard length. The machine is arranged for self-contained motor drive, all motions being obtained from a direct-coupled motor at the rear of the machine, the work being rotated by an endless belt and with the speed varied through the gear box shown on the workhead at the left.

The car axle, illustrated in Fig. 2, is of the type ground on this machine, and while the 4-in. by 9-in. journal is

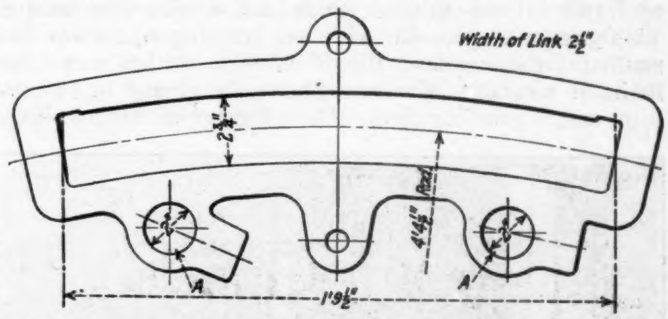


Fig. 4—Common Type of Link Ground on Machine Shown in Fig. 3

small for American practice, the machine could grind a much larger journal just as readily. The journal and wheel seat on each end of the axle are ground in 35 min., the journal fillets being formed by the rounded corners of the grinding wheel. The wheel seats are ground because this gives a uniform, accurate control of finish and diameter which insures uniform mounting pressures and, therefore, less trouble from loose wheels.

A Versatile Grinding Machine

The grinder, illustrated in Fig. 3, is particularly interesting because, while designed primarily for grinding the radius

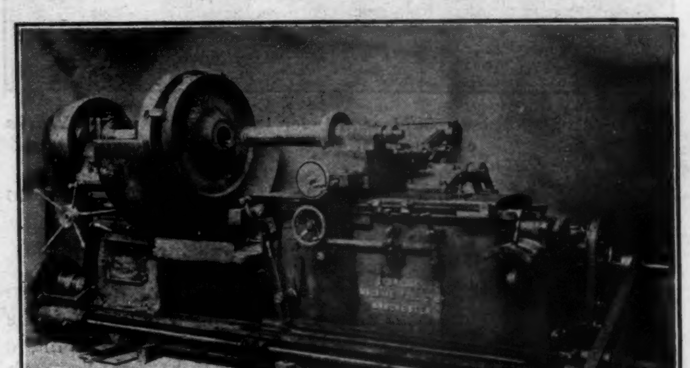


Fig. 5—Grinding Car Wheel Bore in Belgian Car Shop

of links, the spindle has been provided with a planetary motion so that the link pin holes can be ground at the same setting. Moreover, with the table stationary, any small internal grinding job can be done on this machine and it is quite certain to be in continuous use. Relatively small shops, for example, which might not feel justified in buying a machine especially to grind the few links required for its

monthly output of locomotives, would probably be interested in this machine because of its possible use for other work.

Fig. 4, shows the common type of Stephenson link finished on this radius link-grinding machine, .015 in. being removed from the width of the slot in 40 min. The two link pin holes *A* are ground in 5 min. each.

Grinding Car Wheel Bores

It is obviously of little avail to grind the wheel seats on an axle and then apply a car wheel having a rough bore. The old argument of greater accuracy and a more uniform, smooth finish applies in this case, and in the Belgian car shops referred to, the management has followed the only consistent course possible by arranging to grind car wheel bores. The machine illustrated in Fig. 5, is used for this purpose. This is a large powerful machine, the chuck in which the car wheel is applied having a capacity to swing 48-in. The wheel bores are ground by means of the rigid, accurately alined spindle which has a planetary motion. This grinder is provided with wet grinding equipment and maintains the standard size of bores to within very close limits of accuracy. Car wheel bores are ground in 18 min. each, actual grinding time. The diameter of the hole illustrated is 5⅞-in., its length being 7-in. From .015 in. to .018 in. of metal is removed from the diameter by grinding.

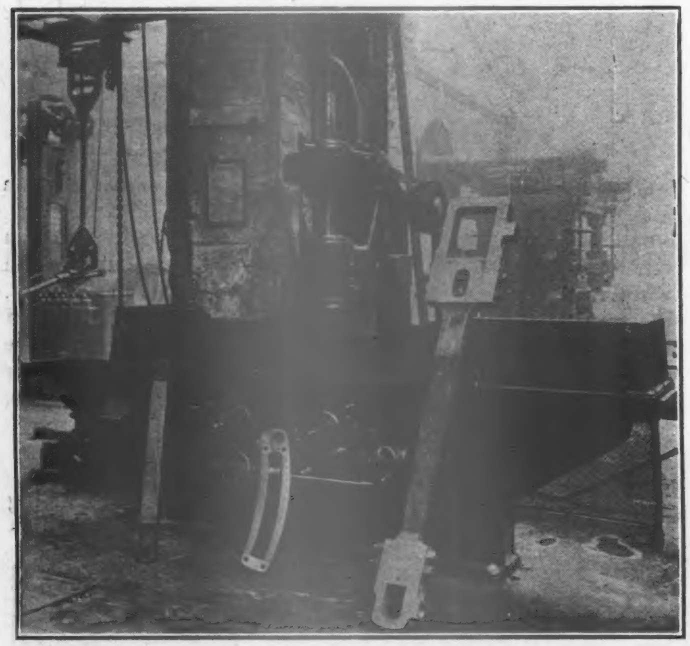


Fig. 6—Vertical Spindle Surface Grinder Installed at Ashford Works of Southeastern & Chatham

Vertical Spindle Surface Grinder

Surface grinding practice is not essentially different in this country than in England, but there is this much to be said in favor of English practice. The grinders are made in quite a number of different sizes and, as a rule, each English shop will have several of these sizes so that it is not necessary to grind small work on a large machine, as frequently happens in this country. The machine illustrated in Fig. 6 is a 16-in. by 72-in. grinder adapted to grind guides, links and rods, such as shown in the illustration. This machine is installed at the Ashford works of the Southeastern & Chatham.

Referring to Fig. 7, the guide illustrated is one of a pair ground as follows: Two guides are ground at the same time, the first operation consisting of grinding the 5½-in. face the full length, about .040 in. of stock is removed in 35 min. The second operation consists of grinding the 5½-in. face 10-in. long, .04 in. of stock being removed in 10 min. The third operation consists of grinding the sides of two of the guides the full length, taking 15 min. The guides are then turned over and brought to the correct width by grinding the two opposite sides the full length. This operation may take 12 min., in which case the total time for the two guide bars is 72 min., or 36 min. a piece. Many other parts can be ground on this machine which is equipped with a magnetic chuck when necessary. Slide valves, false valve seats, steam chests and steam chest covers are also ground to advantage on this machine with important savings over the old method of planing.

Motion Work Pins

In spite of the fact that one or two American roads have gone ahead with the work of standardizing motion pins and

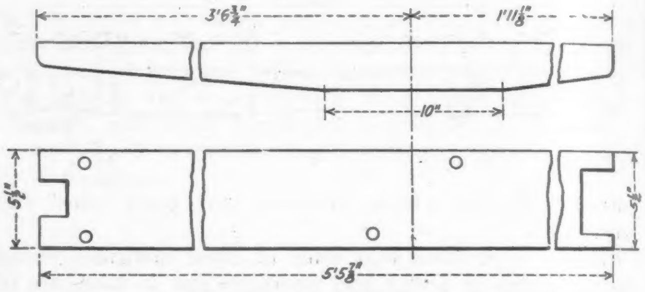


Fig. 7—A Heavy Guide or "Motion Bar" Finished by Grinding

bushings and made arrangements for grinding these parts, the English are, on the whole, ahead of us in this respect. Fig. 8 illustrates a close-up view of a powerful 14-in. plain grinding machine fitted with a 5½-in. wheel for work on motion pins. Where motion pins and short shafts have to be produced in quantities, this method provides an accurate and ultra rapid means of sizing.

For certain work, this machine is fitted with a grinding wheel 8¼ in. wide. The pin shown at *A* (Fig. 9), for example, is ground with an 8¼-in. wheel in 1 min., .041 in. being removed from the diameter with a limit of .0005 in.

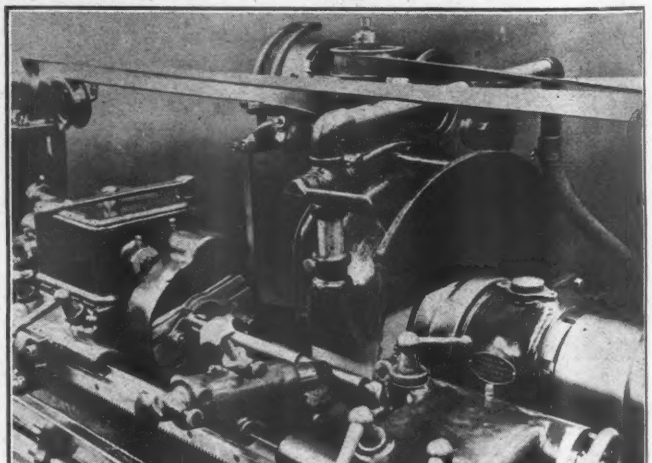


Fig. 8—Plain Grinder with 5½-in. Wheel Grinding Motion Pins

The pin, illustrated at *B*, is finished by removing .032 in. from the diameter, the limit in this case also being .0005 in. and the time, 1 min. Pin *C* is a case-hardened pin, the surfaces indicated being finished by grinding in 3 min., using a wheel with a 2 in. face. Motion pin *D* is finished by grinding on three surfaces in 1 min. Pin *E*, also case-hardened, is finished by removing .015 in. from the diameter by grinding in 1 min. A grinding wheel, having a 4½-in. face, is used.

From Fig. 9 a good idea can be obtained of the types of motion pins suitable to be ground and while all may not agree that it is necessary to grind the taper fit, there is no question that in important shops where a considerable number of valve gears and motion parts are repaired, the pins should be standardized, ground to a fit in their respective bushings, and carried in stock. The volume of pin and bushing work in some shops is extremely large and there is a possibility of real economy by making pins and bushings in quantity on automatic, or semi-automatic machines. The pin fits in the bushings can be ground, thus securing accurate, smooth bearings, and enough material can be left on the taper pin surfaces and outsides of the bushings so that the units will fit with slight additional machining, any standard link or motion bar.

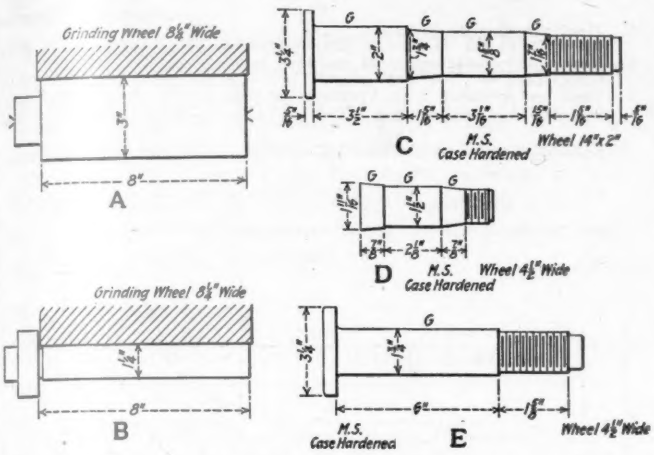


Fig. 9—Showing Several Types of Motion Work Pins as Ground

The quality of the bearing surface is improved by grinding, as would be expected, and an important feature of this method is the increased pin and bushing life. It is well known, for example, that a case-hardened pin put into a case-hardened bushing with a scaly surface and allowed to run shows excessive wear for the first few months, after which there is an undue amount of play at the connection. This is practically eliminated by grinding, because in this case both the pin and bushing are smooth, accurate, cylindrical surfaces, fitted with just the required amount of play. Such a bearing, properly lubricated, is bound to last for a long time without appreciable signs of wear.

Determination of Boiler Operating Factors

Part II

Method of Calculating Combined Efficiency of Boiler, Furnace and Grate—Operating Charts Verify Points

By D. C. Hess

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[The first part of this article was published in the March issue of the Railway Mechanical Engineer, being devoted to a discussion of methods of determining essential factors in the economical operation of boiler rooms. Test results, together with typical performance curves and 24-hour CO_2 charts were included in Part I.—THE EDITORS.*]*

THE principal final product of complete combustion of fuel is carbon dioxide (CO_2). In order to obtain high CO_2 the most important factors to take into consideration are:

First, keep the fuel bed in good condition; that is, prevent the formation of holes in the fire. Maintain the correct thickness and contour of the fuel bed.

Second, eliminate all air leaks in the boiler walls.

Third, maintain as nearly as possible a balanced draft or a slight vacuum in the combustion chamber. Avoid bottling up the gases which would cause a pressure in the furnace. Such a pressure would be very destructive to the brickwork and stoker parts. One type of baffle graduates the cross section of the flue gas passage, so that the velocity of the gas will be uniform throughout the boiler and also eliminate any dead pockets where there is no circulation of gas.

Importance of High CO_2

Fig. 6 is a calculated curve based on the CO_2 per cent by volume at flue gas temperatures of 400 deg. F., 500 deg. F., and 600 deg. F., with no carbon monoxide. Theoretically, perfect combustion of pure carbon will give 20.7 per cent of CO_2 in the flue gases. However, perfect combustion is not possible in boiler room practice.

Referring now to Fig. 6, suppose the flue gases analyze six per cent CO_2 and that by decreasing the amount of excess air and giving careful attention to the fuel bed, the CO_2 is increased to 15 per cent. A glance at the curves

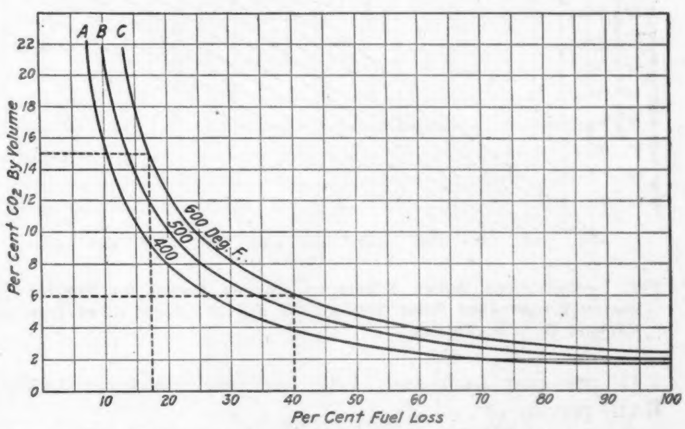

Fig. 6—Calculated CO_2 Curves Based on the Per Cent CO_2 by Volume at Flue Gas Temperatures of 400 deg. F., 500 deg. F., and 600 deg. F., with no Carbon Monoxide Present. Shows Fuel Saving by Increasing the CO_2 Values

shows that the relative fuel loss has been reduced from 40 per cent to 17, which amounts to a fuel saving of 10 to 12 per cent.

Determining Combined Efficiency

The general definition of the efficiency of an apparatus

is the ratio of the energy developed by the apparatus to the energy available for its use.

The efficiencies of the different parts of a boiler installation and of the installation as a whole are defined in so many ways that there is frequently confusion. The following definitions are recommended.

What is ordinarily called the efficiency of the boiler is in reality the combined efficiency of the boiler, furnace and grate, and is the heat absorbed per pound of fuel divided by the heating value per pound of fuel. The value obtained will be approximately the same whether the efficiency is based on dry fuel or fuel as fired. All the fuel is not burned; some of it goes through the grates or is dumped out with the ash while cleaning the fire. It is obviously unfair to charge this loss to the boiler. On the other hand, the boiler user must pay for it and is justified in charging it against the furnace.

The combined efficiency can be expressed as

$$E = W(h + L + sS - f) \div DH$$

Where W = lb. of water evaporated in a unit of time.
D = lb. of coal fired in a unit of time.
s = .48 = specific heat of steam.
h = heat of liquid at steam pressure.
L = latent heat.
S = deg. supt.
$h + L + sS$ = heat in one lb. of steam as delivered by boiler.
f = heat in one lb. of water as received by boiler.
H = heat value of one pound of coal in B.t.u. as fired.

The numerator of the above fraction equals 970.4 Q, where Q is the factor of evaporation.

Specimen Heat Balance

A typical heat balance worked out according to the above formula is given below:

The calculations are made as follows:

24-hour test of 2,400-hp. boiler, operated at 137 per cent of rating.

Coal as fired: 76.87 per cent carbon; 5.31 per cent hydrogen; 7.19 per cent ash; 1.80 per cent moisture; 13,810 B.t.u. per lb.

Dry coal = 98.2 per cent of coal fired.

Dry coal basis: 78.30 per cent carbon; 7.32 per cent ash; 5.41 per cent hydrogen; 1.83 per cent moisture; 14,090 B.t.u. per lb.

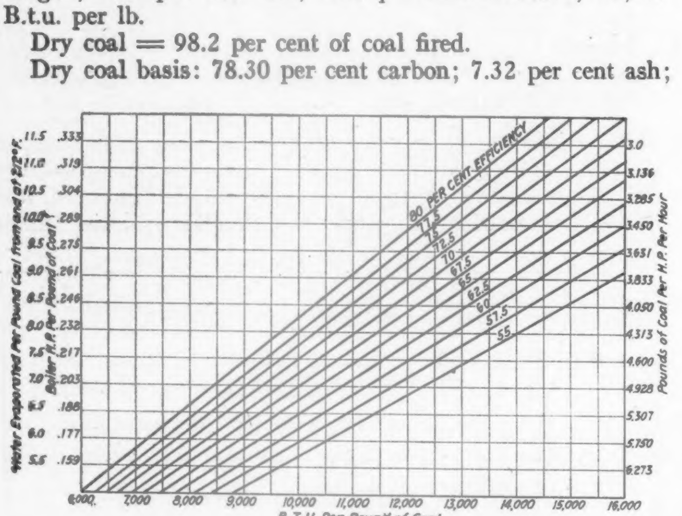

Fig. 7—Combined Boiler Efficiency Curves Based on Pounds of Water Evaporated from and at 212 deg. F. per Lb. of Coal of Various B. t. u. Values

Coal fired 246,000 lb. = 241,500 lb. dry coal.

Refuse produced 21,375 lb. = 8.88 per cent of dry coal.

Carbon in refuse = 8.88 — 7.32 = 1.56 per cent dry coal.

This statement assumes that all of the ash is in the refuse.

Flue gas analysis: 14.6 per cent CO_2, 0.36 per cent CO, and 3.30 per cent O_2. CO is seldom found in the products of combustion, but if produced it is treated as follows in the heat balance.

Water evaporated, 2,480,000 lb., steam pressure 160 lb. gage, superheat 100 deg. = 1,254 B.t.u. per lb. above 32 deg. F.

Average temperatures: feedwater 220 deg. F., flue gas 560 deg. F., room 72 deg. F., air 63 per cent saturated.

Heat Balance Calculations

	B.t.u. per lb. dry coal	Per cent of total heat
1. Heat absorbed by boilers: 2,480,000 (1,254 — (220 — 32)) ÷ 241,500.......	10,960	77.79
2. Heat lost by evaporation of moisture in coal: 0.0183 (212 — 72 + 970 + 0.47 (560 — 212))....	23	0.16
3. Heat lost in steam from hydrogen in coal: 9 × 0.0541 × (212 — 72 + 970 + 0.47 (560 — 212))	609	4.32
4. Heat lost in dry flue gases: Air = 3.036 (0.7830 — 0.0156) (1 — 0.1460 — 0.0036 — 0.0330) ÷ (0.1460 + 0.0036) = 12.45 lb. per lb. of dry coal. Gases 12.45 + (1 — 0.0888) = 13.36 lb. per lb. dry coal. Loss = 0.24 × 13.36 (560 — 72)..................	1,565	11.10
5. Heat lost in unburnt CO = (0.7830 × 10,150 × 0.0036) ÷ (0.1460 + 0.0036) = ...	193	1.37
6. Heat lost in combustible refuse = 14,600 × 0.0156 =	246	1.75
7. Heat lost in heating moisture in air = 63 per cent at 72 deg. F. = 0.0168 × 0.63 = 0.0105 lb. per lb. of air (0.0105 × 12.45 × 0.46 (560 — 72) =	29	0.21
8. Unaccounted for (radiation, unburned hydrocarbon, errors of observation) by difference = ...	465	3.30
Total	14,090	100.00

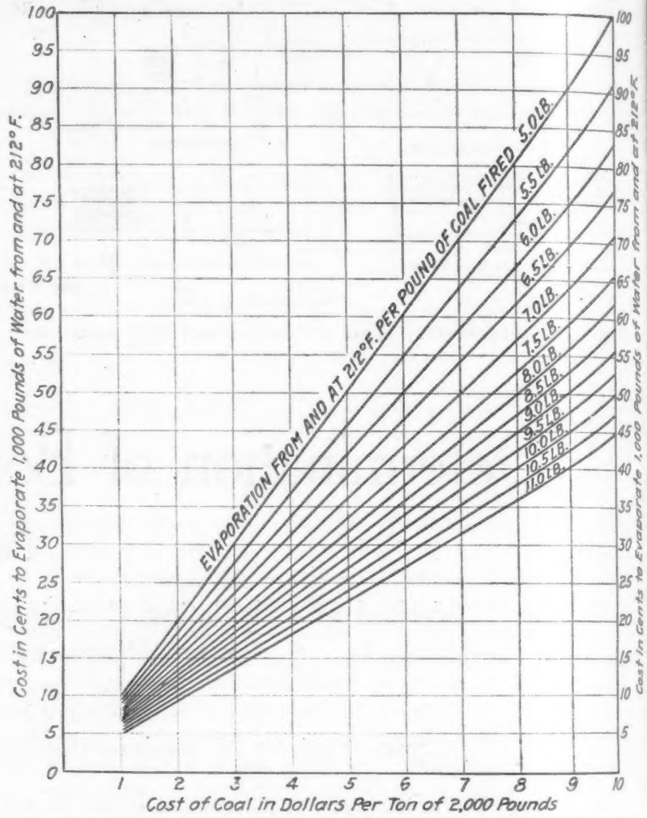

Fig. 8—Cost of Steam Based on the Pounds of Water Evaporated from and at 212 deg. F. per Lb. of Coal Fired

Fig. 7 is a set of curves showing combined efficiencies based on pounds of water evaporated from and at 212 deg. F. per pound of coal at various B.t.u. values. These curves also give the boiler horsepower per pound of coal and pounds of coal per horsepower per hour.

Cost of Steam Curves

Fig. 8 is a set of curves showing the cost of steam based on the pounds of water evaporated from and at 212 deg. F. per pound of coal fired. The column at the left shows the cost in cents to evaporate 1,000 lb. of water which is plotted against the cost of coal in dollars per ton of 2,000 lb.

"The Three Graces"

After you have made a thorough study of your boiler room conditions and heat balance, you will no doubt come to a final conclusion that the economical operation of your boiler plant narrows down to three things.

First, maintaining high CO_2. This means good combustion of the fuel. This is accomplished by keeping the proper ratio between the fuel feed and air supply, good fuel bed conditions and careful attention to the operation of the stokers and boilers.

Second, keeping the flue gas temperature as low as possible. That is, absorb all the heat possible from the furnace gases before they reach the breeching.

Third, reducing the combustible in the refuse as low as possible. This signifies good operation on the part of the fireman who should control the fuel bed conditions so that a minimum amount of carbon is dumped with the ash.

These three items are the main factors in boiler room operation from an economy standpoint.

Triple Valve Piston Press

By J. D. Flinner

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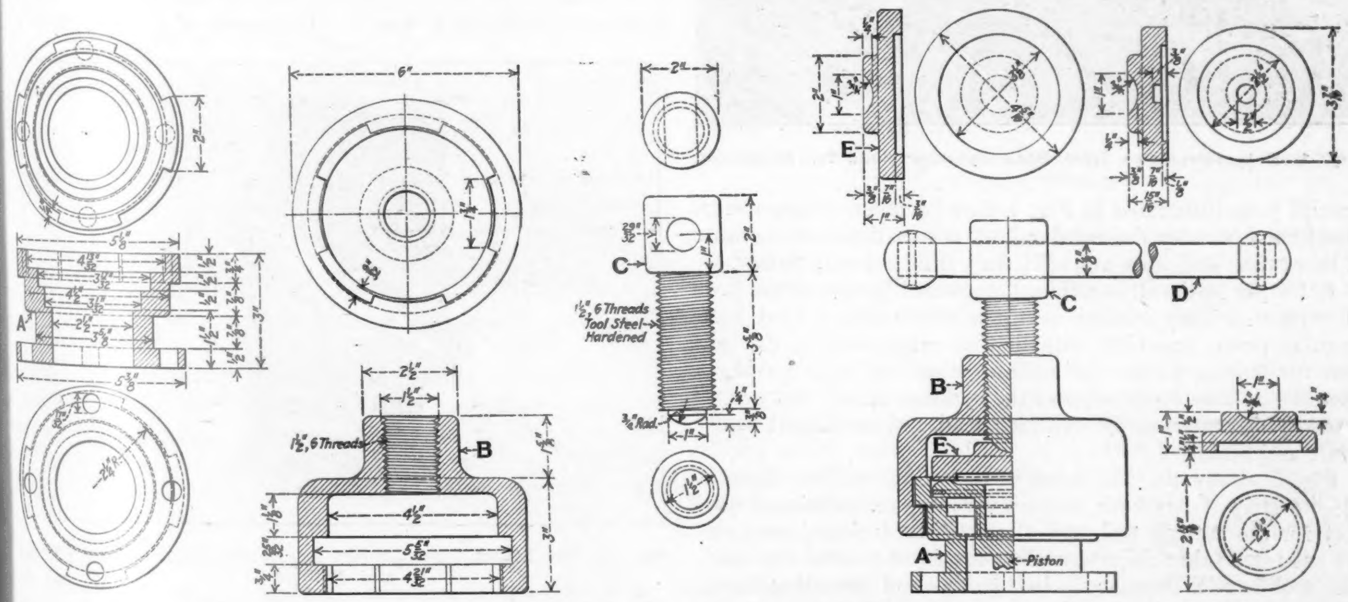
A SMALL hand press, designed to close the piston ring grooves of triple valves, control valves, or distributing valves, is illustrated in the drawing below. In time piston ring grooves wear, and without some means of closing them the pistons must of necessity be scrapped. By using this press, which is bolted to the air brake bench and operated by hand, the piston ring grooves can with a little practice be closed just the right amount for the application of new rings.

In operation, the piston with the oversized groove is placed in base *A* resting on whichever one of the three seats it fits. (The old piston ring is left in the groove to prevent compressing the groove too much.) The proper die, in this case *E*, is then placed on, the piston and cover *B* applied. By giving the cover an eighth of a turn, it is locked in place and cannot come off when pressure is put on the die by means of screw *C* operated by handle *D*. The piston should be turned slightly with each squeeze of the press to assure a uniform closure of the groove and with a little practice grooves can be closed just the right amount. Die *E* is used for the equalizing and release pistons of P. C. control valves. The 3 7/16-in. die at the right is used for all 3½-in. pistons, and the 2 15/16-in. die for New York triple pistons having projections which extend into the die recess.

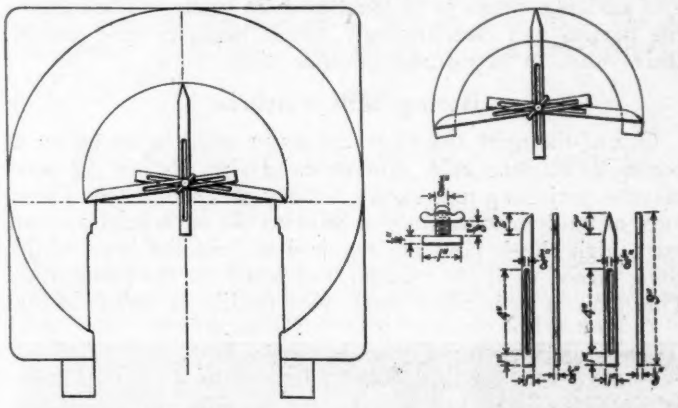
Referring to the detailed drawing of base *A* the 4 13/32-in. diameter seat is used for release pistons and equalizing pistons of P. C. control valves. The 3 17/32-in. diameter seat is used for K1, K2, H1, H2, P1 and P2 Westinghouse triple valve pistons; also for F1, GN1, GN2, K5 and K6 New York triple valve pistons. In general, any of the quick-action triple pistons can be closed on this 3 17/32-in. seat. The plain triple pistons can be closed on the 3 1/32-in. seat.



Piston Ring Grooves in Three Sizes of Triple Valves Can Be Readily Closed in This Simple Press

Driving Box Gage

A GAGE, designed to measure the crown brass fit in driving boxes, is shown in the illustration. This gage can be made with little expense of ⅛-in. boiler steel, cut and filed to the dimensions shown in the drawing. The three parts of the gage are adjustable on each other, being held together by a thumb screw as indicated.



Simple Gage for Measuring Driving Box Crown Brass Fit

The use of this gage, like others of similar type, will save many steps and much lifting when laying out driving box brasses preliminary to machining them for the fit in the driving box. Without some sort of a gage this operation involves placing the brass on top of the box as near as possible in the correct position and scribing the shape of the box on the lower end of the brass. With this gage, the method is to set the gage as shown at the left in the illustration, transferring the marks to the brass as shown at the right. This eliminates a lot of extra handling of the heavy brasses and permits accurate fits to be rapidly made.

Simple Devices Facilitate Machine Work

Description of Several Simple Devices and Methods for Increasing Machine Shop Production

By J. Robert Phelps

Apprentice Instructor, Atchison, Topeka & Santa Fe Shops, San Bernardino, Cal.

THE output of the machine shop of the Atchison, Topeka & Santa Fe at San Bernardino, Cal., as a whole, is greatly affected by a number of jigs, fixtures and simple methods devised for speeding up certain operations and enabling others to be handled more easily. The following devices and comparatively simple methods have proved their value in expediting machine shop work.

Boring Mill Fixtures

One of the most awkward locomotive parts to set up on a boring mill is the back cylinder head with its one or more massive projecting lugs to which the guides are bolted. These lugs, or guide blocks, are cast solid on the back head so that extra high chuck jaws are required to hold the head while being turned to fit the cylinder and bored for the piston rod. This job can be handled much more readily by means of the special jaws illustrated in Fig. 1 than by other arrangements. Blocking up under the regular jaws is unsatisfactory because it takes time and does not hold the cylinder heads firmly.

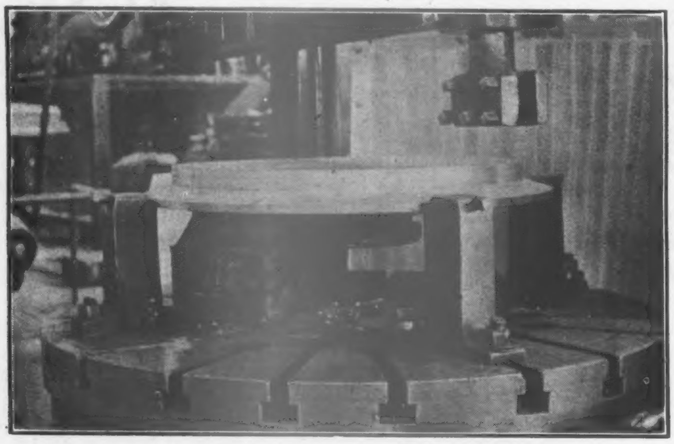


Fig. 1—Extension Jaws Hold Back Cylinder Head for Machining

Referring to the illustration, the general design of the jaws is evident. They consist of three substantial forged rectangular posts, provided with drilled projections at the bottom for bolting to the boring mill table and each having a shoulder at the top to support the cylinder head. Set screws provide for centering the cylinder head and holding it firmly while machining.

Fig. 2 shows the tool head of a boring mill to which a 1½-in. strip *A* has been welded, forming an additional support for the cutting tool and allowing the tool to be set out far enough so that chips can clear the front part of the head. The tool is still supported close to the heel, enabling heavy cuts to be taken without vibration, or excessive stress on the tool.

Holding Steam Pipe Casings

It was formerly the practice at San Bernardino to bolt steam pipe casings to a piece of boiler steel bent to conform to the radius of casings preparatory to machining. By using the method illustrated in Fig. 3, two casings can be handled at the same time. They are simply bolted together and set on the boring mill table, being reversed and re-centered when one end has been machined. After the boring mill work is completed, the casings are left bolted together and sent to the drill press for drilling where the same arrangement is found convenient.

In using this method, the first machine work done on the casings is to drill the holes in the curved, or radius flanges so that the casings can be bolted together. The rest of the machine work is done with the casings bolted together.

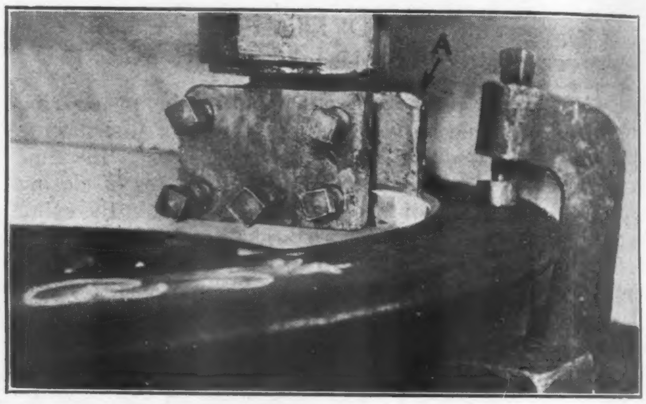


Fig. 2—Additional Support Provided for Back of Boring Mill Tool

Jack for Leveling Rods

A handy and cheaply made jack for use on wooden rod horses is illustrated in Fig. 4. It consists of a 1¼-in. by 16-in. stud to which is electric welded the ¾-in. by 1½-in. by 12-in. strip *S* supporting the rod. Vertical adjustment is provided by a 1¼-in. nut to which ¾-in. handle *H* is attached by electric welding. The use of this device is clear from the illustration which shows one end of a side rod, the other being on a machine ready for boring. The end shown is raised to the proper height by simply turning handle *H* and the nut to which it is welded. This method is more convenient than using blocking, and the handle, being

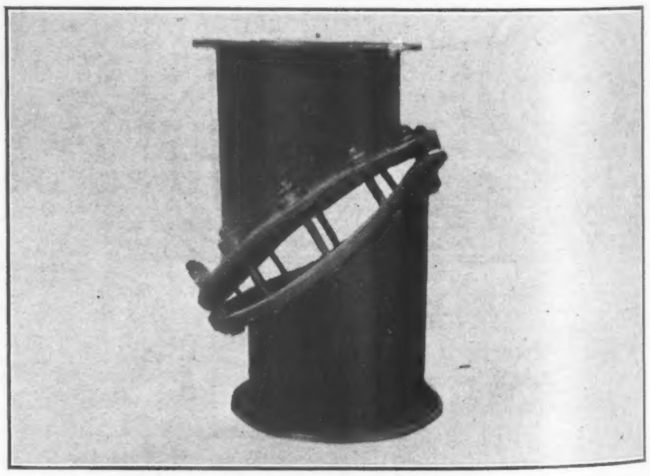


Fig. 3—Two Steam Pipe Casings Are Bolted Together for Boring and Drilling

permanently attached to the nut, is also a convenience. If a wrench is used, it frequently requires both hands and the undivided attention of the operator, whereas with this arrangement the operator can be watching the level on the rod and turn the handle without looking at it.

Adjustment of Slotter Stroke

The figures shown in the following table are stamped on a copper plate and attached to the slotter in the shop at San

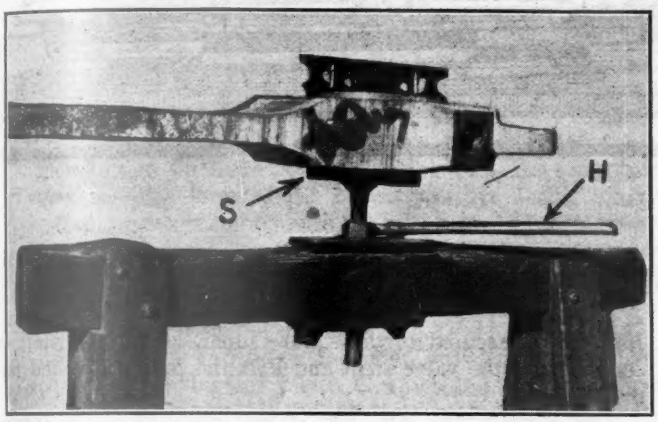


Fig. 4—A Convenient Leveling Jack for the Rod Job

Bernardino. By having this plate to help him, the machinist can set the stroke to exactly the right length he wants on first trial. . He can do it quickly and be sure of it. There is often a tendency on the part of a man operating a machine to get the stroke fairly close and let it cut air above and below the work. While it is realized that the later type of slotters have a stroke indicator, there are many slotters in use where a plate, similar to the one described, will, over a

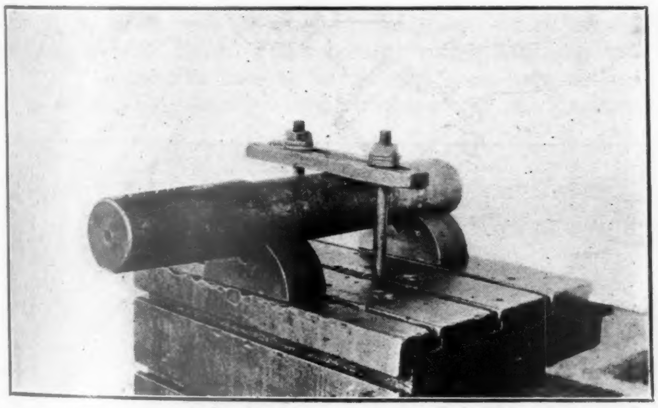


Fig. 5—Mandrel for Use in Drilling Crosshead Keyways

period of weeks or months, prove extremely valuable in increasing slotter production.

Plate for Indicating the Slotter Stroke

Stroke	Distance from Dovetail block to edge of wheel
1 in.	5¾ in.
1½ in.	5½ in.
2 in.	5¼ in.
2½ in.	5 in.
3 in.	4¾ in.
3½ in.	4½ in.
4 in.	4¼ in.
4½ in.	4 in.
5 in.	3¾ in.
5½ in.	3½ in.
6 in.	3¼ in.
....	....
9 in.	1¾ in.
9½ in.	1½ in.
10 in.	1¼ in.
10½ in.	1 in.
11 in.	¾ in.
11½ in.	½ in.
12 in.	¼ in.
12½ in.	0 in.

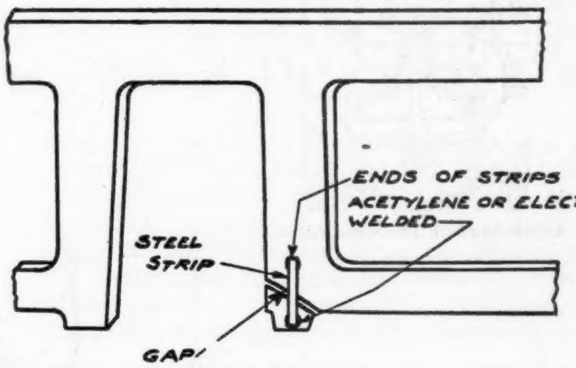
Machining Crosshead Keyways

While it is realized that the correct method of machining crosshead keyways is by milling with an end or side mill, there are many small shops not provided with equipment for handling the work in this way, and roundhouses in particular are not infrequently called on to replace a broken crosshead with a new one in which the keyway has not been machined.

In cases of this kind, the keyway must be drilled and afterwards filed by hand, the question of setting up and holding the crosshead for drilling being something of a problem. A convenient method of holding the crosshead is by means of an old piston rod cut off and clamped to the drill press table as illustrated in Fig. 5. The keyway in this old rod is enlarged sufficiently to clear the drill. A crosshead can then be applied to the mandrel at the proper angle and the keyway drilled without difficulty. The arrangement of V-blocks and clamp is rigid and holds the crosshead firmly.

Risers and Vents for Vertical Frame Welds

In welding a fracture in a vertical locomotive frame member with Thermit, it has not been found advisable to place any risers directly against the frame at the upper edge of the collar because this reservoir of heat so close to the frame is likely to melt away the section above the weld. When the

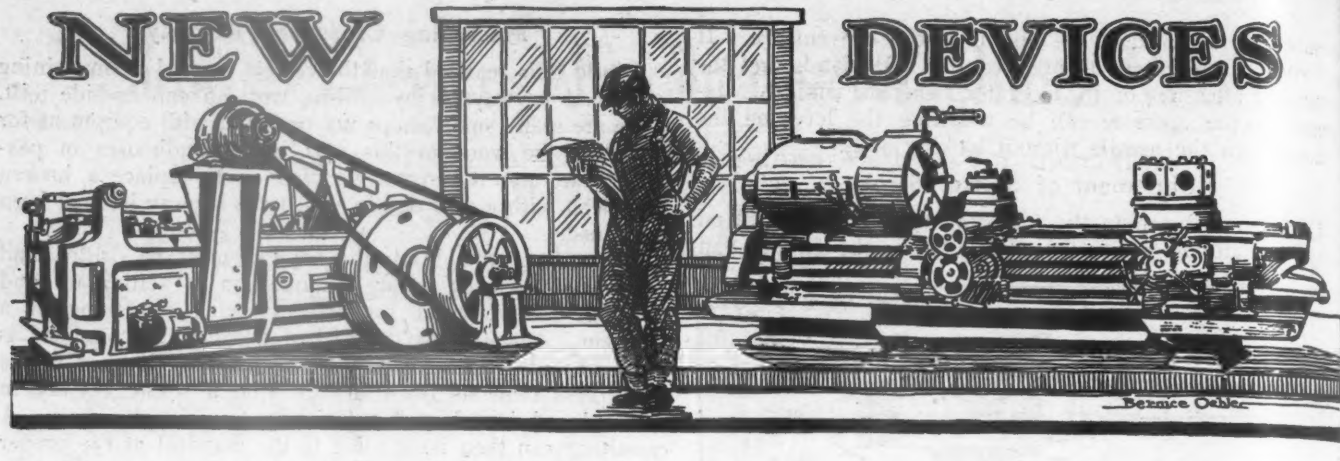


Method of Aligning Broken Head of Frame Preparatory to Thermit Welding

risers are placed ¼ in. or more down from the top edge of the collar, on the other hand, it is evident that there will be a pocket above the level of the base of the riser in which air will be trapped when the mold is being rapidly filled with steel.

It is therefore important that this extreme top edge of the collar all the way around the section should be completely vented to the top of the mold so as to allow the air to escape freely as the mold is filling. It is advisable to lay in, alongside of the frame, thin wooden shims, 1/16 in. to ⅛ in. thick, which are withdrawn after the mold is rammed and, therefore, completely vent the top edge of this collar all the way around. It is true that this space will be filled with steel but the fin will be so small that it will chill against the frame and not weld to it and therefore, can be readily chipped off upon completion of the weld.

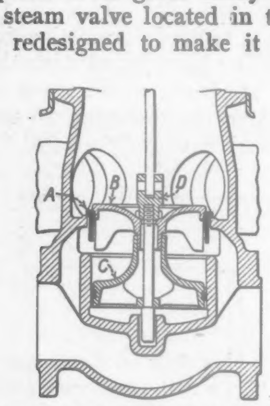
When repairing the fractured heels of frame legs, by Thermit welding, the broken part is held in correct alinement by two 6-in. by 1-in. strips, one laid flush against each side of the frame as indicated in the illustration. About ½ in. of the ends of these strips are welded to the surface of the two parts by means of the oxyacetylene torch or the electric arc.



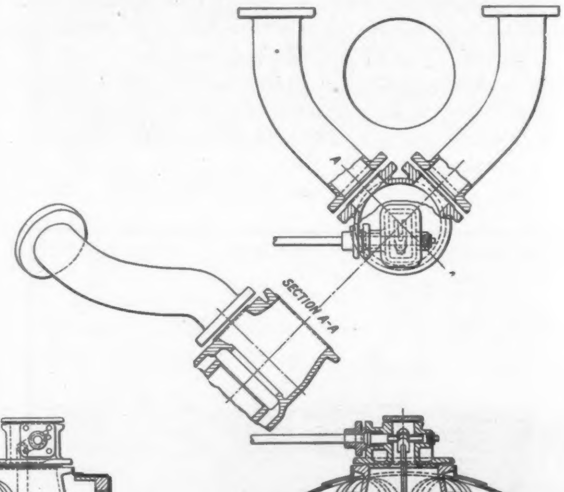
Front-End Locomotive Throttle Valve

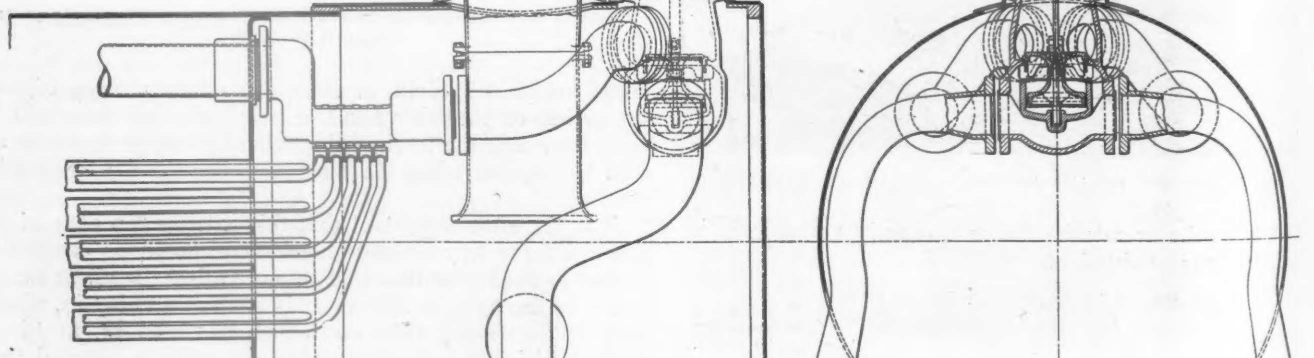
THE Chambers throttle valve, manufactured by the Bradford Draft Gear Company, New York, has been applied to a great many modern locomotives as a saturated steam valve located in the dome. This valve has now been redesigned to make it applicable as a front-end throttle, using superheated steam. The new design, which is illustrated in the drawing, differs in a number of details from the earlier types. The connections from the throttle lever to the valve are carried outside the boiler, the throttle rod connecting to an arm on a rotating shaft which enters the throttle box cover through a steam-tight packing. A forked arm secured to the square inner end of the shaft is connected to the valve stem and lifts the pilot valve and the main throttle.

The throttle box has two steam inlets from the superheater header entering from the rear at right angles to each other and leading to the top of the valve. The outlets to the cylinders are placed on each side at the bottom of the throttle box. This arrangement keeps all the steam pipes entirely inside the front-end. The throttle box is supported by the steam pipes, the joints between the front-end and the throttle box being sealed with a pressed angle. The throttle



Cross-Section Through Valve





Chambers Throttle Designed for Superheated Steam

valve is readily accessible by removing the throttle box cover.

It is a well-known fact that castings when exposed to high temperatures warp and distort. These temperature strains make it difficult to keep throttle valves tight with high pressure steam and especially if it is superheated. The design of the Chambers valve has been worked out carefully to eliminate the effect of these distortions so that the valve will remain tight in spite of warping in the throttle box. The way in which this is accomplished will be evident by an examination of the drawing. It will be noted that the ring seat *A* rests on the throttle box with a flat joint and has a slight clearance in the bore of the box. If the throttle box warps so that the bore is eccentric it still will not affect the tightness of the joints between the box and the ring seat. The main valve *B* rests on a beveled face on the ring seat. When steam is shut off there is no balancing pressure beneath this valve and the force of the boiler pressure acting upon its surface presses it tightly into the ring seat. The ring seat is of relatively light cross section and the force on the main valve is sufficient to cause the seat to conform to the shape of the main valve, thus making a tight joint in spite of any slight distortion in the valve.

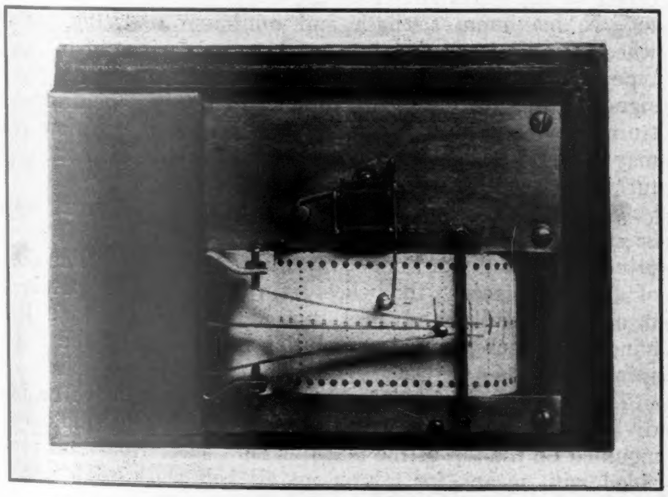
The balancing force on the main valve is secured by the action of the balancing piston *C* which is always tight in the balancing chamber and for that reason the valve is not subject to the troubles due to difference in expansion between the valve and the throttle box which are found with double seated throttle valves. Locomotives with superheaters and a throttle in the dome have a considerable volume of steam space between the throttle valve and the cylinders. When the throttle is opened this space must be filled with steam before the locomotive will start and when the throttle is closed this steam continues to expand so that the locomotive does not stop at once. This sluggishness in responding to the movement of the throttle makes it difficult to handle a locomotive especially on a slippery rail. When a locomotive throttle valve is placed in the front-end, the volume of the steam passages between the throttle and the cylinders is decreased, making the locomotive more prompt in responding to the movement of the throttle.

Superheated steam flows at a higher velocity than saturated steam and for these reasons the fine graduation of the throttle valve opening secured with the Chambers valve is of special importance. The first opening of the throttle is through the pilot valve *D* which permits steam to pass through the center of the main valve to the cavity under the balance piston. A slight amount of steam will flow through the relief opening in the balance piston but this is negligible. When the main valve is lifted from its seat, a small annular passage is opened between the valve and the ring seat. The next steam passage to be opened is a series of 24, ¼-in. holes around the valve skirt. Raising the valve still further gradually opens the passage between the wings on the main valve and the ring seat until the full cross-sectional area of the steam passages is attained.

The Bradford Draft Gear Company favors the use of throttle valves located in the front-end because this arrangement permits the use of superheated steam in the auxiliaries and enables the steam supply to be taken from a large opening at the topmost point of the dome, thus insuring the driest possible steam, the maximum superheat, and consequently the maximum economy in the use of fuel.

Impact Recorder and Pilferage Detector

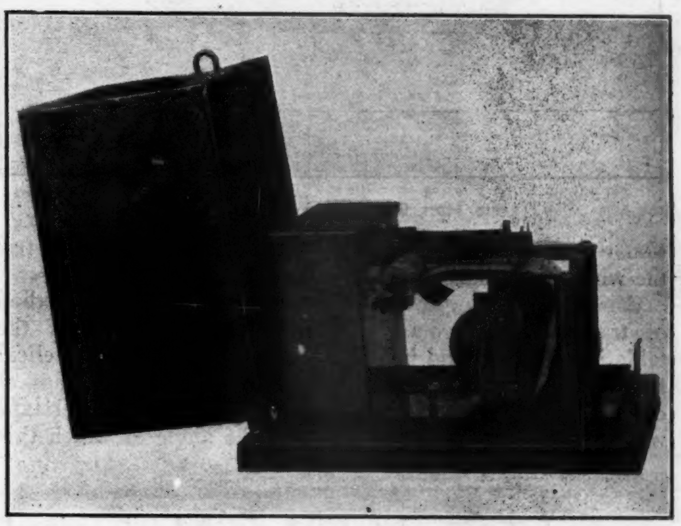
An instrument for use in box cars, which serves the double function of recording rough handling and detecting the time at which cars have been entered for pilfering, has recently been developed by the Impact Re-



Top View of the Impact Recorded with the Cover Removed

corder Company, Burlington, Ia. The impact recorder operates on the inertia principle. The time when the car is entered is recorded electrically by connections attached to the car door. Both records are made on the same tape.

The instrument is equipped with a Seth Thomas No. 10, eight day recording clock movement, which carries a paper tape under the two recording pencils at the rate of one inch an hour. The impact recorder consists of a pencil barrel with provision for inserting and adjusting the lead, which is located at the free end of a flat leaf spring that normally moves in a horizontal plane. The movement of the pencil is restrained by two other flat leaf springs, each of which resist the movement of the pencil from one side of the center line of the paper tape. Each of these springs is prevented from following the pencil across the center line by a stop pin set in a bar which extends across the tape just outside of the pencil. The instrument is calibrated by means of the set screw adjustments on the restraining springs, shown



Side View of the Instrument

in the top view of the instrument, which, once set, are arranged to be permanent.

The instrument case is placed in the car with the springs at right angles to its longitudinal center line. The inertia of the pencil causes it to move laterally whenever the car

is subjected to a sudden change of velocity. The pencil draws a lateral line across the paper, which is calibrated to read directly in miles per hour. A velocity scale is printed on the tape, one for each 12 hours on the one o'clock line. Dots across the paper at each of the other 11 hours, correspond with the above scale reading.

In order that the tape may be readily set to correspond with the time at which the instrument is started, the driving drum is loosely mounted on the shaft. After the paper has been set and suitably marked with the date and a. m. or p. m., the cylinder is clamped to the shaft by tightening the thumb nut on the end of the shaft, shown in the side view of the instrument.

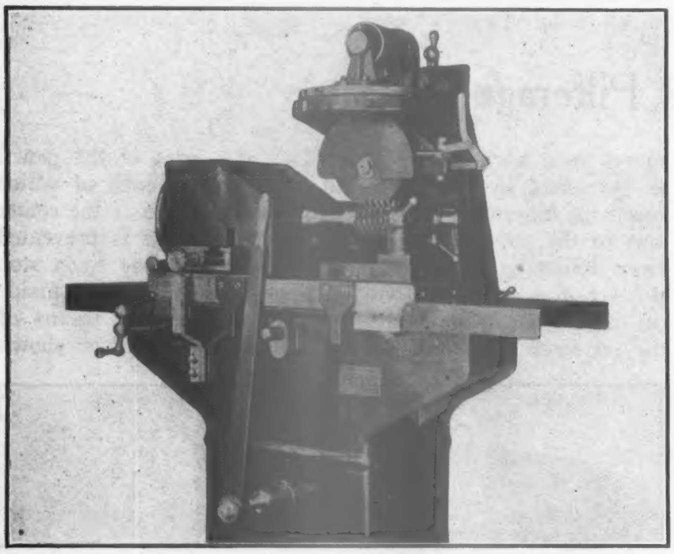
The pilferage detector consists of a buzzer magnet and armature, placed so that the armature extends laterally across the instrument. The outer end carries a pencil which rests on the paper. In order to avoid interference with the pencil of the impact recorder this pencil has been set forward on the scale so that it reads one hour later than the impact recorder. The record is therefore subject to a simple correction by the subtraction of one hour from the scale reading.

The metal box at the end of the instrument contains two dry cells which furnish the energy for the operation of the buzzer. The circuit is completed by wires carried outside the instrument. From binding posts provided for that purpose they are carried to open circuit connections either on the door post or door plate. The circuit is momentarily closed by a spring attached to the door whenever the door is opened or closed. The vibration of the buzzer armature produces a distinct record on the tape.

The weights of the parts of the instrument acting under inertia are so light that it can be used to measure vertical as well as horizontal impact. To measure vertical impact the instrument is placed on its side, in which position the weight of the pencil is not great enough to overcome the resistance of the restraining spring.

Semi-Automatic Hob Grinding Machine

TO meet the demand for a hob-grinding machine for hobs with straight and right- and left-hand helical flutes not over 4 in. in diameter by 5 in. long, the Harris Engineering Company, Bridgeport, Conn., has brought out the No. 5 semi-automatic hob-grinding machine illustrated. All working parts are positively protected from emery dust. The table is operated on ball-bearing rollers, making the action very sensitive and enabling the operator to actually feel the wheel as it sharpens the hob teeth.



Harris Hob Grinder of Improved Design

An important improvement has been made in the method of transmitting a rotary motion during the travel of the table in order to grind hobs having right- or left-hand helical flutes. A lever pivoted in the center with ball bearings at each end is connected to the work spindle by a steel tape wound upon a drum. By changing the angle at which this ball-bearing lever operates, a positive helical motion is generated during the travel of the table.

The index plates are of heat-treated chrome-nickel steel, accurately cut from a master plate. They are double, one plate being used for indexing and the other plate for escapement. The escapement pawl is provided with an adjustment to take up wear. By being so designed, the wear all comes upon the escapement plate and there is no wear on the set for indexing, thus maintaining its original accuracy. The indexing mechanism is semi-automatic and can only operate at the end of the return stroke, thus preventing any damage to the wheel or hob by accidental indexing in the middle of a stroke. Indexes are changed in 60 seconds by merely unscrewing the hand wheel. The wheel spindle is driven by an endless open belt without twists, turns or idler pulleys. The largest wheel used is 7 in. in diameter. The wheel head and column are so designed as to have the center of the wheel swivel on the center line of the table and to give maximum strength and minimum overhang. The wheel spindle is carried in large bronze bearings of oil well type construction, is dust proof and has an especially designed device for taking up thrust and wear. The diamond truing device is built in the head, is always in position and may be used when the machine is in operation without disturbing the work.

This machine may be set at will to grind undercut hobs or cutters and to give them so-called top rake as well as to grind them in the ordinary way with radial face. The feed of the hob against the wheel is rotative and is obtained through a small handwheel, turned by the operator's left hand after each complete revolution of the hob on the work spindle.

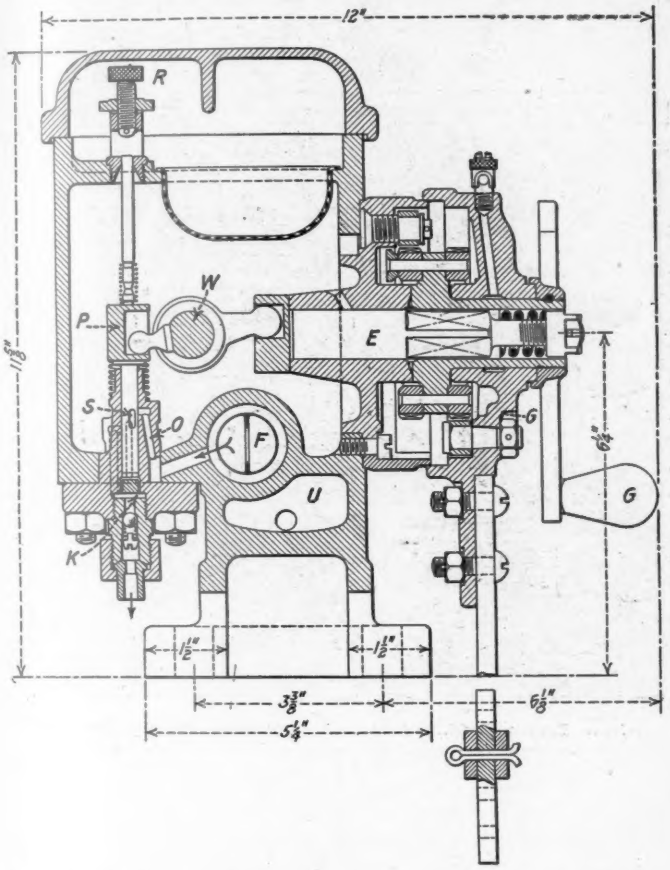
The machine is furnished with countershaft drive or individual motor drive. With motor drive, the motor is mounted on the top of the machine on a special pedestal provided with means for taking up all belt slack. This machine is usually equipped for dry grinding, but can also be provided with pump and piping for wet grinding.

Valveless Mechanical Locomotive Lubricator

THE type DV mechanical locomotive lubricator, illustrated, is made by the Nathan Manufacturing Company, New York City. It is a development of the Friedman lubricator, of which more than 60,000 have been applied to European locomotives. This lubricator is valveless, the operation of its working pistons or plungers being independent of the action of check valves. Inside the oil reservoir there is a separate valveless pump for each feed.

This pump, consisting of a plunger which in its highest and lowest position automatically opens and closes the oil inlet opening and oil outlet opening through a turning movement of the plunger, eliminates the necessity of all suction and discharge valves.

The operating movement of the mechanical lubricator is taken from some point on the motion work of the engine

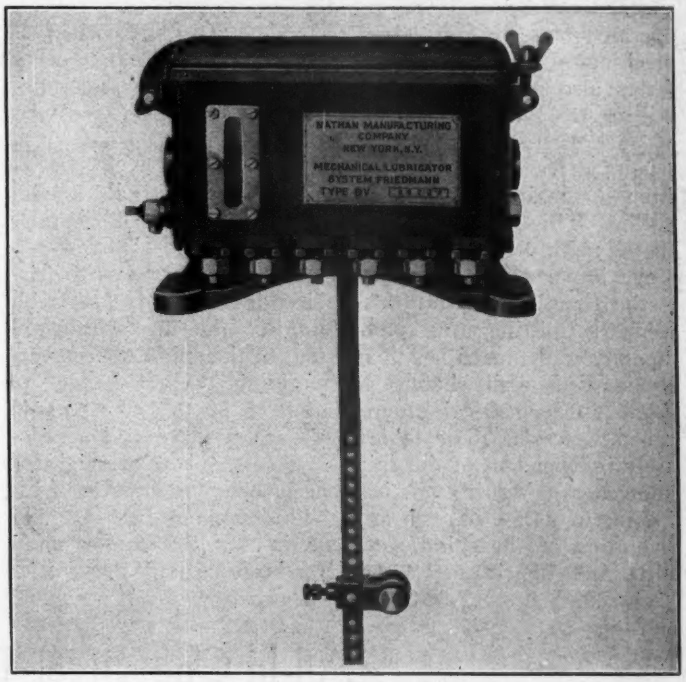


Cross-Sectional View Showing Operating Parts of Nathan Valveless Mechanical Lubricator

where the stroke is fairly constant, so that the set movement of the lubricator will not be influenced by variations in cut-off of the engine. A useful auxiliary of this device is an indicator which shows at a glance whether the oil pipes are filled with oil at the proper pressure and if not, the trouble can be located.

The Nathan mechanical lubricator may be obtained with two forms of terminal check, one for use when the oil is being delivered to the steam pipes and the other for applications in which the oil is delivered into the cylinders. The lubricator is simple in operation requiring little attention. The engine crew and roundhouse men have only to keep it filled with oil. The correct rate of oil feed is permanently set by the mechanical department. The engine starts the lubricator and the engine stops it.

The operation of this lubricator will be evident from the drawing. The crank disc on the end of the ratchet shaft *E* contains a circular hole which receives the ball end of the rocker arm attached to the shaft *W*, so that as the ratchet shaft rotates the vertical component of the circular motion of the hole causes the shaft *W* to oscillate while the horizontal component causes the shaft to slide back and forth. These oscillating and reciprocating motions are definite since the arm is rigidly attached to the shaft *W*. These two motions are utilized to operate the plungers for pumping and for the control of admission and discharge of oil. Each plunger is operated by a small arm rigidly attached to the shaft *W* acting on a cross head-like extension of the plunger *P* which is provided with an elongated slot. The upward motion of the plunger is effected by means of a spring below the cross head, and downward motion is effected by the small arm attached to the shaft *W* coming in contact with the bottom of the slot in the cross head. The turning movement of the plunger causes a groove *S* in the plunger to make connection from the plunger cylinder to the suction chamber *O* at the up-stroke



Nathan Type D V Valveless Mechanical Lubricator

and with the discharge chamber *K* on the down-stroke. The up-and-down motion of the plunger may be observed through the small chamber below the regulating screws, an extension rod being attached for that purpose to the top of the plunger.

High-Production Automatic Milling Machine

The No. 33 automatic milling machine, illustrated, is a new product of the Brown & Sharpe Manufacturing Company, Providence, R. I., primarily designed for the automatic milling of duplicate parts in large quantities. The machine has many structural features and improvements over those of the ordinary manufacturing type. The ways are exceptionally wide and heavy; the automatic oiling system designed to be efficient, effective and thorough; and the controls are entirely within the machine.

A unique feature is the automatic control of the spindle and table. Adjustable dogs at the front and rear of the table make the control of the table and spindle entirely automatic. The available movements include a variable feed, constant fast travel and stop for the table, start and stop and right and left-hand rotation for the spindle. The table and spindle may be operated independently of each other and these movements may or may not be intermittent in either or both directions and may take place one or more times. The spindle may be stopped when the table is on its return travel, thus eliminating the possibility of marring

the work. The spindle reverse allows the use of two sets of cutters with teeth facing in opposite directions so that one set may be in operation with either direction of table traverse. A constant fast travel and a slow variable feed of the table in either direction are automatically controlled by the table dogs. The machine can be set and the dogs will operate the table independently of the spindle.

All the automatic operations of the machine are performed through the medium of the adjustable table dogs and four different styles of dogs are necessary to operate all the automatic movements of the machine. However, for ordinary milling operations, two or three of the types are usually sufficient. The spindle can be set to start, stop or reverse automatically, or it can be set to run continuously in either direction.

Although the automatic control of the spindle and table is by means of the table dogs, the same result may be obtained by hand by means of the two controlling levers conveniently located on the front of the saddle. If the loading time of a piece exceeds the cutting time, the table is set to stop for the safety of the operator. Under these conditions the machine is semi-automatic in operation, the hand control levers being employed in place of the dogs.

The manipulation of these controlling levers is extremely simple and the ease and rapidity with which they may be operated in some cases gives faster operation than when the machine is fully automatically controlled. The hand control levers also permit the operation of the machine as a plain milling machine, accomplishing within its capacity all that of an ordinary plain milling machine. The constant speed type of drive permits the machine to be driven by belt direct from the main shaft or counter shaft to the single driving pulley. This pulley runs at a constant speed and is mounted on the main driving shaft.

An important feature of the constant speed type of drive is the complete separation of the spindle speeds and table feeds, permitting any combination of the two within the capacity of the machine. Variations of the spindle speeds are obtained through change gears giving twelve changes of speeds in geometrical progression from 22 to 180 r.p.m. in either direction. The table feeds are positive and are entirely independent of the spindle speeds. There are eighteen changes ranging in practically geometric progression from .38 in. to 24.54 in. per min. This provides a range per revolution of the spindle of .002 in. to .136 in. for small mills, and .017 in. to 1.115 in. for large mills.

This machine is exceptionally well adapted to a motor drive as provision is made for neatly enclosing a constant speed motor in a chamber within the base. The cutting lubricant is pumped to the work from a large tank cast in the base. Two nozzles are provided and, therefore, if two cutters are used, each has ample cutting lubricant at all times. Provision is made for cutting off the supply to either or both nozzles if it is not needed.

New Brown & Sharpe No. 33 Automatic Milling Machine

The machine has a longitudinal feed of 34 in., transverse adjustment of 5¼ in., and vertical adjustment of spindle, 15 in. The hole through the spindle is 13/16 in., the spindle having a No. 11 taper hole. Constant speed drive at 350 r.p.m. is recommended. The working surface is 52 in. by 12½ in. There are 3 T-slots, ⅝ in. wide. The net weight is 7,200 lb.

All-In-One Steel Figures Save Time

An ingenious arrangement of steel figures, with important advantages over the individual steel figures or letters commonly used, is shown in the illustration and has been placed on the market recently by Marburg Bros., Inc., New York. The method of using these figures is plainly shown at the left in the illustration and a close-up view at the right. The figures are cut around one-half of the circumference as indicated.

Many obvious advantages result from this arrangement including in the first place the saving of a large amount of time formerly spent hunting for the correct individual figures. The All-In-One is more convenient to handle, with less danger of smashed fingers, and vertical figures or letters are produced with ease. In addition, the speed of stamping is greatly increased and the figures never get upside down. Shattering is prevented and the general appearance of the lettering is improved. There are no individual figures to be lost or disarranged.

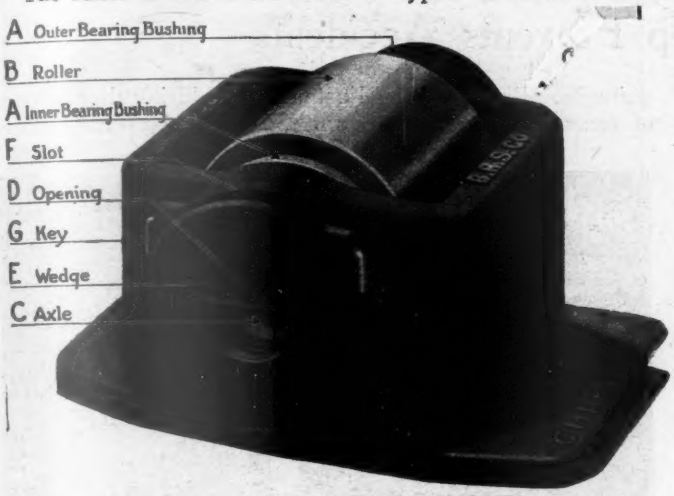
The All-In-One can be furnished for metal, wood, or leather in seven sizes from 1/16 in. to ⅜ in. In case alphabets are desired they can be furnished on three discs.

View Showing Method of Using All-In-One Steel Figures

Paragon Continuous Roller Side Bearing

A CONTINUOUS roller side bearing, the housing of which is protected against wear from the roller axle bearings, has been placed on the market by the Burry Railway Supply Company, Chicago. The bearing is known as the Paragon frictionless side bearing and is designed for use on passenger equipment.

The roller is not of the trunnion type. It revolves on a removable axle which is inserted through one end of the housing and is held in place by a wedge and key which are



The Housing of the Paragon Roller Side Bearing Is Protected from Wear by Removable Axle Bushings

located in the inner end of the housing. The housing is protected from destruction from the rapid wearing out of the axle bearings by the insertion of interchangeable bushings, shown at *A* in the illustration. In assembling the bearings these bushings are inserted in the housing from the inside and are provided with chafing flanges which bear against the inside faces of the housing. The lower half of the bushings and the pockets in the housing are semi-hexagon in form, thus preventing the bushings from turning in the housing, and the bearing area of the hexagonal surfaces is large enough to protect the housing against cutting out from the pressure on the bearing. The thickness of the metal in the lower half of the bushing has been made great enough to insure a considerable length of service before renewal becomes necessary.

In assembling this side bearing the bushings are first slipped into the pockets in the housing. The roller *B* is then inserted between them, thus locking them in place, and the axle *C* is inserted through the opening *D* in the inner end of the housing. The outer end of the housing is closed, thus preventing the axle from slipping through, and a thin wedge *E*, inserted in the slot *F* at the inner end of the housing, closes the opening through which the axle is inserted. The wedge is locked in place by the insertion of the wire pin *G*.

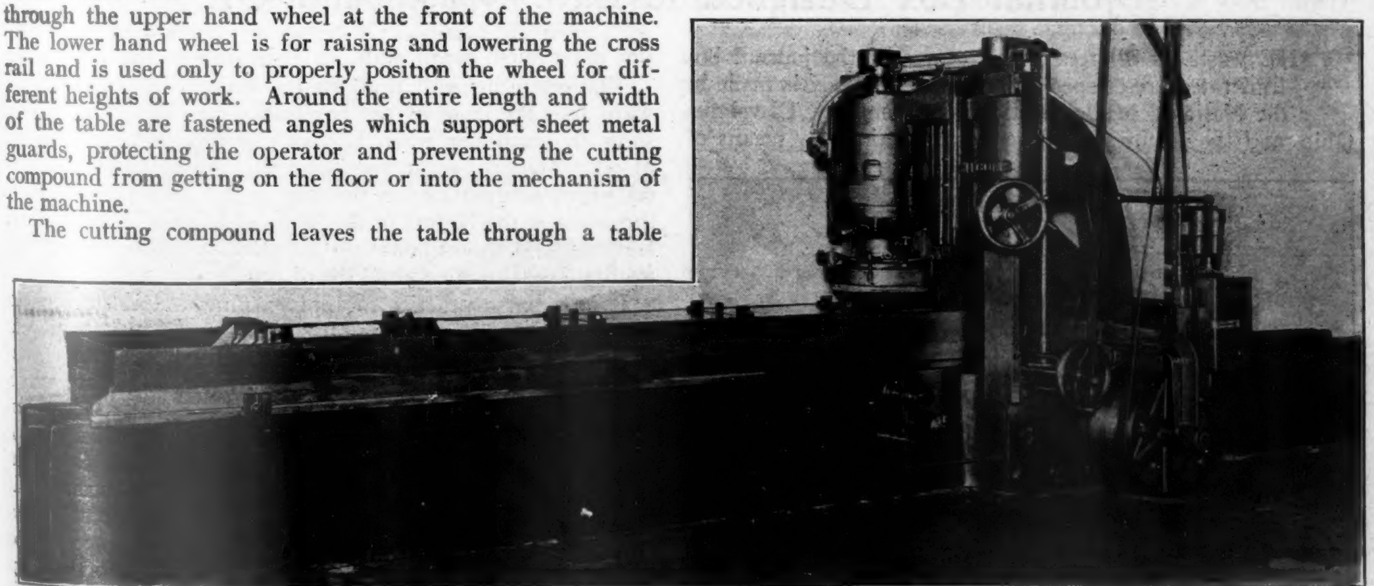
The bearing bushings are easily renewed without removing the housing from the bolster and renewal of these bushings restores the bearing to its original condition. While intended primarily for application to the truck bolster, the Paragon side bearing may be inverted if desired and applied to the body bolster.

Planer-Type Surface Grinding Machine

THE new grinding machine illustrated consists of the bed, table and housings of a 36-in. heavy duty planer with a special cross rail, on which is mounted a self-contained 25-hp. motor-driven grinder head, carrying a 20-in. wheel. The vertical movement of the head is obtained through the upper hand wheel at the front of the machine. The lower hand wheel is for raising and lowering the cross rail and is used only to properly position the wheel for different heights of work. Around the entire length and width of the table are fastened angles which support sheet metal guards, protecting the operator and preventing the cutting compound from getting on the floor or into the mechanism of the machine.

The cutting compound leaves the table through a table spout, and flows through metal troughs to receiving and supply tanks, located in the floor. The cutting compound is delivered to the wheel from a pump in the supply tank through two 1-in. pipes, one to the inside of wheel, the other to the outside.

The work is held by six magnetic chucks with a magnetic surface of 14⅛ in. by 19¾ in. A cast-iron spacer between each chuck insures the work being supported its entire length against the thrust of the wheel. On the cast-iron spacers are mounted side guides and spacers, and at one end a work "bunter' is provided. These are necessary in case the electric



Reed-Prentice 36-In. Planer-Type Surface Grinder Driven by Self-Contained 25-Hp. Motor

current to the chucks should be shut off while the wheel was traveling over the work.

The machine will grind work 19¾ in. wide by 15 ft. long and 10 in. high above the magnetic chucks. The machine is equipped with a two-speed countershaft for driving the table, and the two speeds provide for roughing and finishing cuts. The roughing cuts are taken at a table speed of 30 ft. per min., the wheel cutting both on the forward and return strokes. The finishing cuts are taken at a speed to suit requirements.

Although this machine was designed for grinding cast-iron channels, and is longer than ordinarily used in railroad shops, it can be used for finishing rods and other long parts. It can also be obtained in shorter bed lengths for grinding locomotive guides and other parts. The machine is made by the Reed-Prentice Company, Worcester, Mass.

Extension Coach Step Prevents Accidents

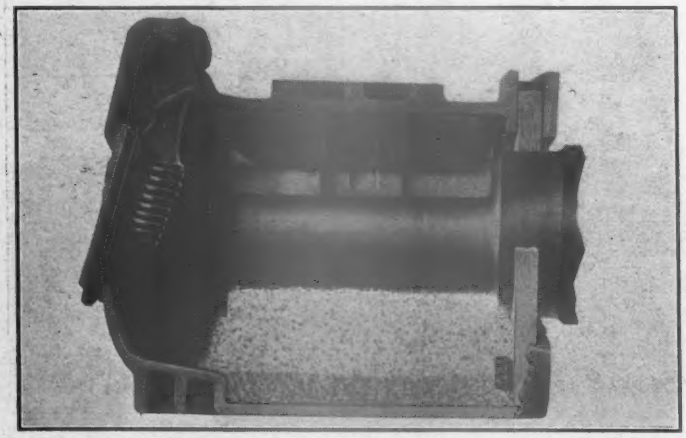
IN 1916 the Duluth, Missabe & Northern began the equipment of its coaches with an extensible coach step the patents on which were secured and are owned by John T. Rodenbur, a conductor on that road. This device, which was illustrated and described in the *Railway Mechanical Engineer* for March, 1917, page 163, has been in general service on the passenger equipment of the Duluth, Missabe & Northern for more than six years. In that time the railroad has not had a personal injury to a passenger caused while getting on or off a train. The illustration, which shows the extensible step both in the operating position and drawn up closely under the bottom fixed step, suggests the type of accident which the step prevents. Prior to the general application of this device, which is known as the Rod-En-Bur extensible step, several personal injury suits had been filed against the railroad as the result of accidents caused by passengers slipping off the step box or tipping it over. The latter type of accident was the more common.

The step is of simple construction and is easily operated by a lever in the end of the vestibule. The guides in which the side bars of the extensible step operate are fitted with roller bearings. A simple interlocking device makes it impossible to lower the step while the vestibule trap door is closed and makes it necessary to raise the step before the vestibule side door or trap door can be closed. The original cost of applying the step under conditions as of 1916 was approximately $50 per car. Once installed, the device requires no lubrication or adjustment and during the six years of general service on the Duluth, Missabe & Northern there is reported to have been practically no expenditure for maintenance chargeable directly to this step.

The Rod-En-Bur Safety Coach Step Renders Effective Service on the Duluth, Missabe & Northern

Journal Box Designed to Save Waste and Oil

THE waste an oil retaining features of the journal box illustrated are of special interest. This box is made by the National Malleable Castings Company, Cleveland, Ohio, and the features mentioned are obtained by means of a retaining wall or shoulder on the floor of the box directly underneath the end of the journal, and an oil port through the inner dust guard wall, as indicated in the illustration.



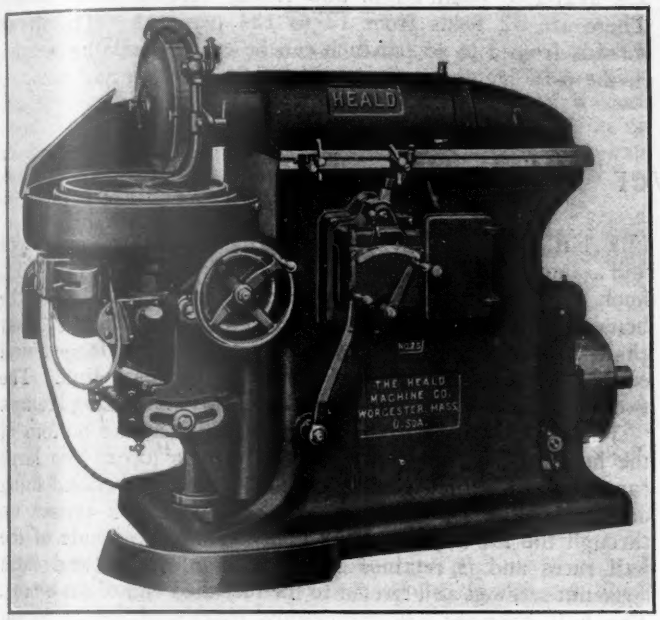
National Journal Box with Waste and Oil Retaining Features

The retaining wall prevents the waste from working forward into the front of the box and serves as an oil gage to show the inspector when he has supplied the right amount of oil. The oil port in the inner dust guard wall allows the oil which accumulates in the dust guard pocket to return to the waste at the bottom of the box and be used again. These features tend to eliminate the liability of hot boxes with the resultant loss of time and cost of repairs.

It is common practice to apply a plug and waste between the end of the journal and the front of the box to prevent the waste working forward and leaving the back of the journal without any waste contact. The arrangement shown, which is known as the Tatum-Zell entirely eliminates this front plug, as the collar of the journal and the shoulder in the floor of the box retains the waste in position. With this front plug eliminated the oiler can readily see the amount of oil contained in the box. The above features also result in a saving of oil since the amount available in the box can be determined at a glance. Attention is also called to the large and powerful coil spring which insures positive closing of the journal box cover. This is a special feature of the National coil spring journal box, the entire design of which has been developed along practical lines suggested by actual service requirements.

Powerful Rotary Surface Grinding Machine

THE most rigid and powerful rotary surface grinder yet produced by the Heald Machine Company, Worcester, Mass., is its No. 25 model illustrated. While designed for big production and grinding parts from the rough to a smooth concentric finish, this machine is of a relatively inexpensive type, having the further advantages of low wheel maintenance cost, provision for quickly changing grinding wheels, and small power consumption compared to work done.



Heald No. 25 Rotary Surface Grinding Machine

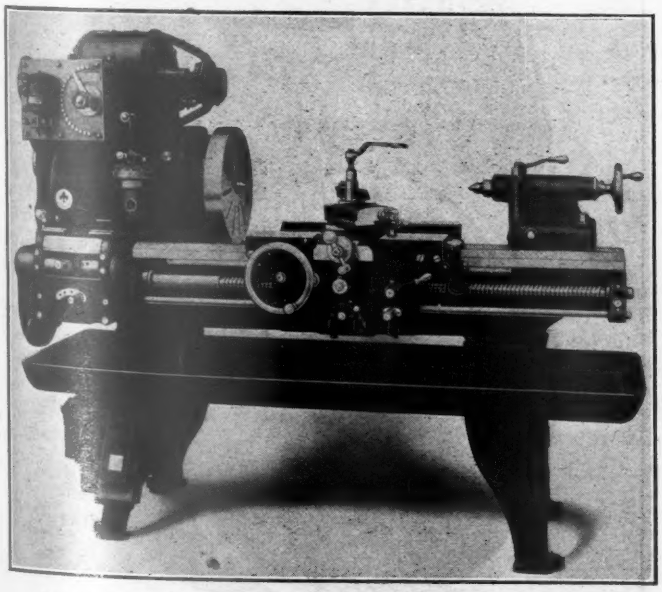
This machine is provided with a quick return wheel slide, hydraulically driven by oil, enabling the operator to get any speed desired. Operation of an auxiliary speed valve also enables a slow forward travel and a quick return to be obtained, when it is not desired to have the same speed on both the forward and backward strokes. With the slow forward travel it is possible to remove a large amount of stock with very slight wheel wear while the quick return immediately moves the wheel back into position for a second cut or new work.

The chuck is mounted on a spindle, supported by oil submerged bearings housed in the chuck bracket. This bracket can be raised and lowered by a hand wheel and can be tipped for concave and convex grinding. Special top plates can be furnished suitable for odd shaped work. The wheel is mounted on a chrome vanadium steel spindle, carried in an adjustable bronze bearing at the front and in S. K. F. ball bearings at the rear end. The grinding wheel cuts on the periphery which tends to provide long wheel life. Wheel changes can be made in three minutes.

The main drive shaft at the rear of the machine is mounted on ball bearings and may be driven directly from the main line or motor. This machine is furnished with any one of three sizes of magnetic chucks, 8 in., 12 in., or 16 in. in diameter. Automatic vertical feed for the chuck can be provided if desired. The water equipment includes the pump, tank, water guard and connections. The maximum swing with the 16-in. chuck is 20 in. inside the water pan. The vertical adjustment of the chuck is 7⅞ in. The machine will grind concave 5 deg. and convex 15 deg. Tight and loose pulleys 15 in. in diameter with a 5½-in. face, running at a speed of 550 r.p.m., are required. For motor drive a 10-to 15-hp. motor is recommended, running at a speed of from 850 to 1,200 r.p.m. depending upon conditions.

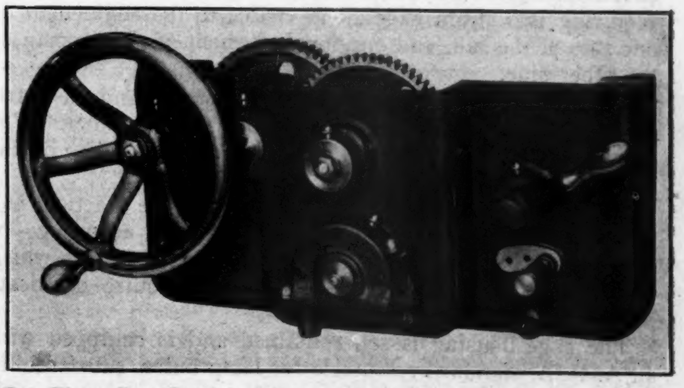
Variable-Speed Geared Motor-Driven Lathe

THE variable-speed geared motor-driven lathe, illustrated, is one of several models of heavy duty lathes recently put on the market by the R. K. LeBlond Machine Tool



Le Blond 15-In. Lathe with Driving Motor on Headstock

Company, Cincinnati, Ohio. These lathes, made in 13-in. and 15-in. sizes, can be supplied with 3-step cone, double friction back gear head, or single pulley drive geared back. Motor drive can also be provided. Besides the wide variety of modern drives offered, these lathes have other distinctive features including a new one-piece box section apron with positive tooth feed clutch, improved heavy duty carriage and a bed with ample strength for the duty imposed on it. The



One-Piece Box Section Apron with Positive Tooth Feed Clutch

lathes are of exceptionally rigid design, embodying high power, convenience of operation and accuracy.

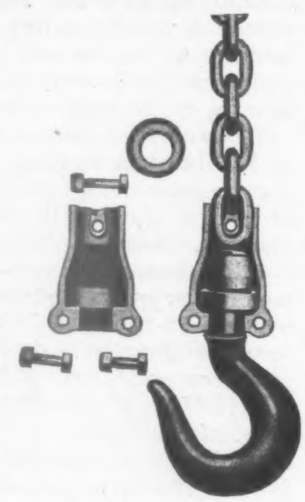
With motor drive, two types are offered including belted motor drive for constant speed motors and variable speed geared motor drive, as illustrated, for direct current variable speed motors. In this arrangement the lathe is equipped with automatic controllers embodying a dynamic brake. The

motor is mounted on top of the headstock and the drive is through a motor pinion and intermediate gear to the broad faced gear that replaces the driving pulley. In this construction the first series of gear changes in the headstock are omitted, the speeds being obtained electrically. On lathes with beds 6 ft. or shorter, the clutch-operating lever is also eliminated, the spindle being controlled by the lever on the electric starting box. This lever controls both the forward and reverse rotation of the spindle and in the "off" position applies the dynamic brake bringing the spindle to an instant stop. On lathes with beds longer than 6 ft. apron motor control is supplied instead of apron mechanical control. When more convenient the motor can be mounted on an adjustable motor plate attached to the leg of the lathe and driving through an endless double leather belt to the driving pulley.

In the 15-in. size the swing over the shears is 16¼ in. and over the carriage 11¼ in. Nine forward spindle speeds are available from 20 to 350 r.p.m. (geared head lathe). There are 32 feeds from 12 to 184 per inch. Thirty-two threads from 3 to 46 per inch can be cut. The lathe weighs, in the 6-ft. length, ready to ship, 2,015 lb.

Chain Hoist Lower Hook Swivel

A NEW style of ball bearing swivel hook connection for the ends of hoisting chains has been developed by the Wright Manufacturing Company, Lisbon, Ohio, as illustrated. This swivel eliminates the necessity of pulling and tugging at the load to get it into the desired position. Ease of swiveling permits heavy loads to be turned on this hook by a small expenditure of energy.



Ball Bearing Swivel Hook

In construction the hook connection is practically indestructible, with a large drop forged housing enclosing the entire bearing and chain connection. The housing is split its entire length, being clamped together by three steel bolts, held by castellated nuts. The top bolt passes through the lower chain link but only acts as a reinforcement to the connections and clamp for the housing as the load on the hoist hook is supported by bosses forged in each half of the housings, these bosses meeting each other inside the lower chain link so that the hook is held on an area of forged steel equal to the clearance on the inside of the chain link. The two lower bolts of the connection serve only as housing clamps.

The lower ball race rests on a shoulder at the bottom of the housing. The upper race rests on the top of the large capacity balls which easily accommodate any overload hung on the hook. The straight shank of the hook passes up through the lower part of the housing and the inside of the ball races and is retained in place by a washer and extra large nut screwed and riveted to the threaded end of the shank. The ball bearings are thoroughly lubricated so as to insure easy frictionless action and to overcome all difficulty in positioning heavy loads. The new Wright swivel hook should prove of special value in railroad shops because of the large number of such hooks used on cranes and hoists in the various shop departments, many of the hooks now in use being home-made and inferior as regards safety and ability to swivel easily under heavy loads.

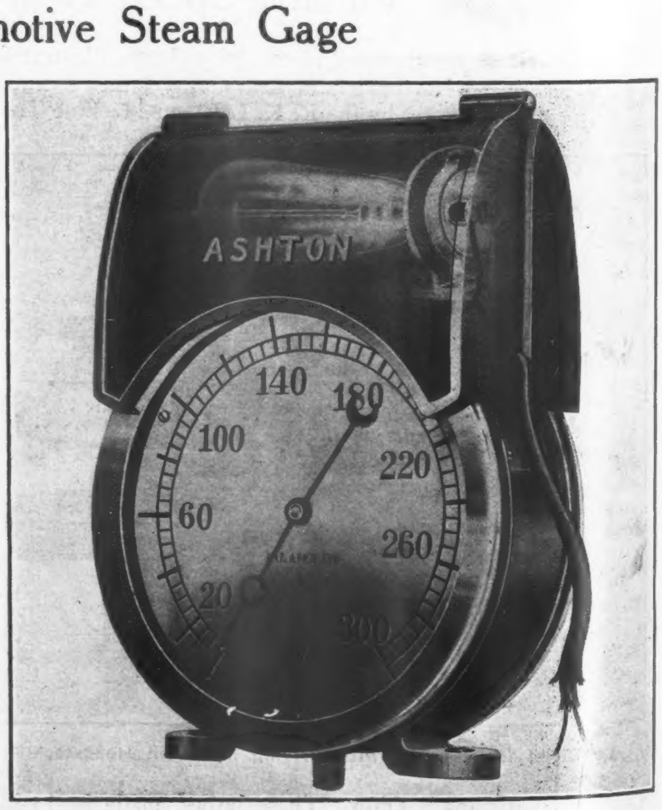
Double Dial Locomotive Steam Gage

THE double dial locomotive steam gage, illustrated, is a recent development of the Ashton Valve Company, Boston, Mass. It is particularly designed for use on large oil-burning locomotives and locomotives having large fireboxes with boiler heads extending back into the cabs, requiring two steam gages, one visible to the engineman on one side of the cab, and one for the benefit of the fireman on the other side.

The gage is constructed with two hands and also two dials which are opposite and parallel to each other. The hands work clockwise on one dial and contraclockwise on the other.

Illumination for both dials is provided in the practical and compact manner illustrated. The particular advantage of this gage is in eliminating the necessity of two gages which take up valuable space in the cab and require duplicate piping.

The gage housing is self-contained and is equipped with an A. R. A. standard receptacle for lamp bulbs, substantially fastened to the top of the gage. The arrangement is such that light is reflected downward on the two dials in such a manner as not to interfere with the vision of the engineman. The dials are finished either silvered or black, as specified, and are regularly graduated to 300 lb. or 400 lb. These gages are made only in the 3¾-in. dial size, being contained in dust-proof brass, or iron cases, with threaded valve brass rings and having ¼-in. standard pipe thread connections. If desired, gages are furnished without the light attachment.



Double Dial Steam Gage with Electric Light Shown in Phantom

GENERAL NEWS

Group insurance, life, accident and health, is to be provided for the shopmen, said to number 10,000, on the Great Northern Railway by the Metropolitan Life Insurance Company, of New York City. The scheme is similar to group insurance arrangements on other roads, but it is said that the shopmen's brotherhood deals directly with the insurance company, the railroad company not being a party to the contract.

Employees of the Philadelphia & Reading in Philadelphia have been invited by the management to attend a series of noon meetings in the Young Men's Christian Association to listen to short addresses on railroad work, the purpose being to acquaint the employees of each department with the work done in other departments. The first subject dealt with was company welfare work; other subjects include fuel; materials and supplies, disbursement and conservation; freight traffic; movement of trains, the personal touch; what is done with the railroad's dollar; what is involved in a locomotive; light railway operation on the Western front in the War; creating travel.

2,000 Cars to Be Built in Chile

The Chilean government has decided to place an order for 2,000 steel freight cars to be built in Chile, according to Commerce Reports.

The Southern's Expenditures for Equipment

New cars and locomotives costing $17,000,000 have been ordered recently by the Southern Railway. This is in addition to equipment costing $13,000,000 purchased in 1922, making a total outlay of $30,000,000 for equipment by the Southern Railway in two years.

New Officers of Pacific Railway Club

The Pacific Railway Club of San Francisco, Cal., has elected the following officers to serve during 1923: President, F. S. Foote, professor of railroad engineering, University of California; vice-presidents, J. N. Clark, chief fuel supervisor, Southern Pacific, and J. M. Yount, master mechanic, Market Street Railway; treasurer, R. G. Harmon, chief clerk, Western Pacific—Denver & Rio Grande Western; secretary, W. S. Wollner, general safety agent, Northwestern Pacific; governors, G. W. Rear (Southern Pacific), C. E. Norton (Southern Pacific), D. Wood (Southern Pacific) and G. H. Harris (San Francisco-Oakland Terminal).

Questionnaire on Freight Cars

The American Railway Association has recently sent out Circular No. 2350 requesting from the railroads information regarding freight cars owned, the original cost and the cost of maintenance for the year 1922. The first part of the circular is arranged for a report of the average number of cars maintained and the total charges for repairs, retirements, depreciation and taxes. In the second part of the circular the equipment is separated according to type and each type is sub-divided into groups according to capacity. Data is requested under each of these divisions covering the number of cars owned, the original cost of cars, the number of cars destroyed and acquired, the average age of cars and the total number of car-years represented in each group.

The Pennsylvania's Equipment Orders

New equipment ordered by the Pennsylvania to be placed in service this year—some of it already being delivered—involves an expenditure of more than $57,000,000. In order to handle its share of the country's growing business—normally about 11 per cent of the freight and 17 per cent of the passenger traffic of the nation the company is making large additions to its present car and locomotive capacity.

Since the first of this year, the Pennsylvania has ordered 500 new steam locomotives, for delivery this year in time to be of service when business ordinarily reaches its maximum activity in the fall. In addition to those locomotives, deliveries have been completed on the 100 heavy freight locomotives ordered last August. Final deliveries are now being made on 250 passenger cars ordered last year and 15 passenger locomotives being built at the company's Altoona Works. Three new and improved electrical locomotives and 100 caboose cars are also under construction.

Last fall an order for twenty new all-steel dining cars was completed at Altoona Works. About the same time work was started on an important addition to the company's coal carrying capacity by changing 50-ton trucks to 70-ton trucks under about 10,000 coal cars. This change increases the capacity of these cars by approximately 31 per cent.

Biggest Testing Machine in the World

A crushing force equal to the weight of fifty loaded coal cars of a hundred tons each can be exerted by the largest testing machine in the world, which is now being installed at the Bureau of Standards. This machine has been in use for several years at the branch laboratory in Pittsburgh and has recently been moved to the main laboratory in Chevy Chase, a suburb of Washington, D. C.

This machine has two massive heads, one set in a concrete foundation beneath the laboratory floor, the other supported on four steel screws, each over a foot in diameter, and two stories high. The upper head may be set at any height by turning the nuts on the screws by means of an electric motor.

The specimen to be tested is placed in the machine by an electric crane capable of lifting twenty tons. The upper head is brought down until it rests on the specimen and the load applied by a huge hydraulic jack built into the lower head. The piston of this jack, on which the specimen rests, is lifted by oil forced into the cylinder under a pressure of 5,000 lb. per sq. in. by a motor-driven pump.

This testing machine will be used mainly for investigating the strength of long columns such as are used in bridges and buildings.

Continuous Brakes in France

The Conseil Superieur des Chemins de Fer has at length decided the much-vexed question of what type of continuous brake is to be favored for freight trains. The technical commission, appointed a year ago, reported in favor of the Westinghouse, but the three experts charged later by the Minister of Public Works with the task of further examining the merits of the three rival systems, Westinghouse, Clayton-Hardy and Lipkowski, came to the conclusion that more trials should be made, especially with a view to considering the advantages of the Clayton-Hardy. The council then handed over the question to another commission, whose report came up before it a short time ago.

The council unanimously adopted its conclusions, but as to what these conclusions are there is no official statement. It would be safe to guess, however, that they favor the Westinghouse brake, and that the French Government will accordingly recommend its adoption by the Powers signatory to the Berne Convention. Whether it will be adopted as the unique international brake, however, is another matter. The extensive application of the Kunze-Knorr system in Germany and elsewhere, despite the treaty of Versailles, does not bar the way to use of the Westinghouse in other countries, since both are air-brakes and can be employed indifferently without inconvenience to international freight traffic. Incidentally, it is learned that the German Government's offer to install the Kunze-Knorr brake on the French railways as part of the reparations' payment has been refused. The Supreme Railway Council, in endorsing the conclusions of its commission, stipulated that all apparatus for the French railways should be manufactured in France.

The Railway Motor Finance Corporation

The Railway Motor Finance Corporation has been organized under the laws of Illinois, for the purpose of assisting member lines of the American Short Line Railroad Association, and others, in the purchase and operation of railway passenger and express motor cars. Plans have been formulated whereby prospective purchasers of motor cars may finance their needs on a lease purchase basis, paying approximately 25 per cent cash and the balance over a maximum period of four years.

The corporation was organized following the receipt of answers to questionnaires sent to the entire membership of the Short Line Association. Since the total outlay for motor cars by any one road is insufficient to justify a separate car trust, it was necessary to organize a corporation through which the motor car requirements of a large number of lines could be combined. The corporation held its first meeting in Washington on March 3, at which J. W. Cain, manager of purchases, was elected president; L. S. Cass, president of the Waterloo, Cedar Falls & Northern and A. C. Moore, vice-president of the Chicago Railway Equipment Company, were elected vice-presidents and A. M. Fornwald was elected secretary and treasurer. In addition, Bird M. Robinson, president of the American Short Line Railroad Association; Ben B. Cain, vice-president and general counsel, T. F. Whittelsey, secretary and treasurer, and F. J. Lisman were elected directors. The principal office of the corporation will be at 616 Railway Exchange, Chicago, Ill.

N. Y. C. Ordered to Pay Hourly Instead of Piece Rates Retroactive to 1921

Shop employees of the New York Central who have been on piece work schedules since November, 1921, must be paid on an hourly basis under the terms of a decision handed down by the Railroad Labor Board on March 22. The board's ruling also provided that the employees affected should be compensated for the period of time that they were paid on piece work schedules at a wage rate "the average of which shall not be less than the hourly rates established by the decision of the board relating to such employment."

This ruling upholds the contention of representatives of the shopmen involved, who contended that the piece work schedule was introduced without proper negotiation and that the Transportation Act had consequently been violated. The Board held that the piece work schedules were not in conformity with the Transportation Act "because the employees were deprived of the right to negotiate such an agreement through their duly authorized representatives."

Economical Gasoline Rail Car on Middletown & Union

The Middletown & Union, a road 15 miles long, serving a farming district with four small villages, has obtained excellent operating results from a gasoline motor passenger car. This car, furnished by J. Blaine Worcester, Middletown, N. Y., was built around a Gramm-Bernstein 3-ton truck chassis, with a special frame. The light weight is 8,700 lb., which is equivalent to 281 lb. for each of the 31 passengers for which seats are provided.

The power is furnished by a Hinkley engine, with four 4¼ in. by 5½ in. cylinders. It is governor-controlled at a speed between 1,250 and 1,300 r. p. m., which corresponds to a piston speed of 1,200 ft. per min. The maximum speed of the car in full gear is 29 m. p. h.

The front truck is of the four-wheel type, while the drive is on the two-wheel trailing axle. The steering wheel has been converted into a brake-wheel controlling the brakes on the front truck, while a service foot-brake and an emergency lever-brake act on the rear wheels and wheel drum, respectively. There is also an electric brake, which employs a small motor, driven by current from a storage battery to rotate a screw and thus apply the brakes.

In November, 1922, the car made 107 round trips of 30 miles each, during which time the gasoline consumption was 251 gallons, or almost 13 miles to a gallon. The passengers carried during the month totaled 2,179. In December, when there was considerable snow and sleet, the gasoline consumption was at the rate of a gallon for each 10 miles run. The consumption of engine oil is from three to four gallons a month.

MEETINGS AND CONVENTIONS

Traveling Engineers to Discuss Train Control

Automatic train control will be one of the topics discussed at the next annual meeting of the Traveling Engineers' Association. The committee on this topic has recently issued a questionnaire requesting information regarding the devices in service, number of engines equipped, length of time device has been in service, the cost of installation and maintenance, and objectionable and desirable features as developed in service.

American Welding Society

At the annual meeting to be held at the Engineering Societies' building, New York, April 24-27, 1923, the following subjects will be considered: Training of operators; Resistance welding; Electric arc welding; Welding of storage tanks; Developments in welding field; Specifications for steel to be welded, and Gas welding.

American Foundrymen's Association

At the annual convention to be held at Cleveland Auditorium, Cleveland, Ohio, April 30-May 3, 1923, the following subjects will be discussed: Industrial education and training of apprentices; Pattern practice; Phosphorus and sulphur in steel; Molding sand research; Steel castings; Grey iron castings; Heat treatment of ferrous castings; Corrosion of metals; Malleable castings; Non-ferrous castings; Refractories; Coal and coke; and Metallography. In addition, there will be joint reports of the American Foundrymen's Association and the American Society for Testing Materials on the following subjects: Car wheels, Cast iron pipe, Soil pipe and General castings.

Central Railway Club

Until recently the Central Railway Club has held bi-monthly meetings. Three months ago it decided to hold monthly meetings during the season, every other meeting, however, being in the nature of a topical discussion or open forum, without a formal paper. At the meeting on Thursday evening, April 12, 1923, at the Hotel Iroquois, Buffalo, at eight o'clock, the following topics will be discussed:

1. Errors in billing.
2. Preparation of cars for flour and grain loading.
3. Is it preferable to provide an outside inspection pit where locomotives can be inspected and minor repairs such as tightening, etc., be done previous to placing locomotives in engine house?

Master Boiler Makers' Association

At the fourteenth annual convention to be held at Hotel Tuller, Detroit, Mich., May 22-25, 1923, committee reports will be presented on the following subjects: Are Combustion chamber boilers as easy to maintain as straight standard firebox, Henry J. Raps; Finished material (boiler plates) should be sound and free from cracks, surface flaws and laminations, and no hammer dressing, patching, burning or electric welding allowed, Charles P. Patrick; Best methods of detecting defective boiler sheets, John J. Keogh; Hammer testing of staybolts, J. A. Holder; Standard method of applying flues, Albert F. Stiglmeier; Is the use of automatic stokers injurious to firebox sheets, H. A. Bell; Care of water tube stationary boilers, J. J. Davey; Steam leaks and bad effects on boiler plate, D. A. Lucas; Life of the superheater tubes and safe-ends, J. P. Malley; Experience with electric weld heater, John W. Holt.

Railroad Session at Spring Meeting of A. S. M. E.

During the Spring Meeting of the American Society of Mechanical Engineers, which this year is being held at Montreal, Quebec, the Railroad Session will be held on Tuesday morning, May 29, 1923.

Papers of more than ordinary interest at the present time are being prepared and will be presented. One paper entitled, "Construction of Steel Frame Box Cars by the Jig Method," is to be presented by H. R. Naylor, assistant works manager, Canadian Pacific, Angus shops, Montreal, Quebec. The paper will be descriptive of the modern methods employed at this shop and fully detail the jig method of car construction which marks a definite step forward in the building of railway cars. The author has done

a great deal in the development of this method and is fully qualified to present the topic.

The paper on Railroad Motor Cars by C. E. Brooks, chief of motive power of the Canadian National Railways, Toronto, Ont., promises to be of more than ordinary interest. The Canadian National Railways have tested out a large number of cars of this character and experiences with, and qualifications of, various designs will be given.

Fuel Association Organizing Local Chapters

Periodical meetings in the principal railroad centers to stimulate interest in fuel matters is one of the activities recently undertaken by the International Railway Fuel Association. In December, 1922, President J. N. Clark, acting upon authority of the Executive Committee, requested members in some of the larger railroad centers to organize district chapters. This work is now being carried forward and the District of Columbia Chapter, which was organized on January 10, 1923, has already held two meetings. The subjects discussed by this chapter included: Forms of Fuel Contracts; Practicability of Fuel Purchase on Specification Basis; Methods of Fuel distribution by Direct Consignment from Mines to Coaling Station and Otherwise, and Supervision of Locomotive Operation. The Chicago District Chapter held a meeting on March 12 at which W. E. Dunham, assistant superintendent motive power and machinery of the Chicago & North Western, presented a paper on Cold Weather Practices as Related to Fuel Conservation. Each section will be allowed to work out its own program for the discussion of problems of local and general interest. It is thought that by holding informal meetings each thirty or sixty days, the members will be able to carry out the objects of the organization to better advantage and promote the best methods for fuel economy in their own territory.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, May 1 to 4 inclusive.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamilton Ave., Chicago.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Annual meeting, Chicago, beginning June 20, 1923.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

Division VI—Purchases and Stores.—W. J. Farrell, 30 Vesey St., New York. Next meeting, Chicago, May 22, 1923. Annual meeting, Hotel Sherman, Chicago, May 15, 16 and 17, 1923.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., beginning June 25, 1923.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Next meeting April 10. Paper on The Legal Department of the Railway and Its Functions will be presented by E. B. Flintoft, assistant general solicitor, Canadian Pacific, Montreal, Canada.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, Great Northern Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill. Next meeting, May 21-24, 1923, Cleveland, Ohio.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabash Ave., Winona, Minn. Annual convention, Hotel Sherman, Chicago, September 4-7, 1923.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Annual convention, Hotel Fuller, Detroit, Mich., May 22 to 25 inclusive, 1923.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting April 10. Annual entertainment, Copley-Plaza Hotel.

New York Railway Club.—H. D. Vought, 26 Cortlandt St., New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 605 North Michigan Ave., Chicago.

SUPPLY TRADE NOTES

Joseph T. Ryerson & Son, Chicago, have taken over the Cincinnati Iron and Steel Company, Cincinnati, Ohio.

C. R. Lewis, general manager of sales of the Standard Forgings Company, Chicago, has been appointed vice-president.

B. L. Worden, has been elected director and vice-president of the Cutler-Hammer Manufacturing Company, Milwaukee, Wis.

A. C. Goodale has been appointed branch manager of the Cutler-Hammer Manufacturing Company, with headquarters at Detroit, Mich.

R. E. Janney, consulting engineer of the coupler department of the American Steel Foundries, Chicago, died on March 2 in Chicago.

W. C. Irwin has been appointed southwestern sales manager for the Union Railway Equipment Company, with headquarters at St. Louis, Mo.

Columbus K. Lassiter, president of the Consolidated Machine Tool Corporation of America, New York City, and formerly vice-president in charge of manufacturing of the American Locomotive Company, died from a sudden heart attack while driving his automobile in New York City on March 3. He had served also the Bausch Machine Tool Company, Springfield, Mass., as a controller, and was a director of many other corporations. Mr. Lassiter was born in Suffolk, Va., and was 57 years of age at the time of his death. He served with the American Locomotive Company for 29 years at Richmond, Schenectady and New York. His first position with this company was that of timekeeper at Richmond and he was promoted until he became general mechanical superintendent. About nine years ago he was elected vice-president in charge of all manufacturing, from which position he resigned on July 1, 1922, to become president of the Consolidated Machine Tool Corporation of America which he was instrumental in organizing. He served as president of the Consolidated Machine Tool Corporation up to the time of his death. Mr. Lassiter was the patentee of a number of machine tool and railroad appliances, chief of which was staybolt machinery now in general use in most of the railroad shops in this country.

Columbus K. Lassiter

Edwin Henry Benners, an inventor of railway appliances and formerly a manufacturer of lubricating oils, died on March 9 at Elizabeth, N. J.

The Reliance Manufacturing Company, Massillon, Ohio, has opened a district sales office in the Fullerton building, St. Louis, Mo., in charge of A. C. Rule.

A. S. Littlefield, western sales agent of the Loraine Steel Company, with headquarters at Chicago, died on March 4 from heart trouble at his home in Chicago.

The Walter A. Zelnicker Supply Company, St. Louis, Mo., has removed from 325 Locust street to new offices in the Chamber of Commerce building, 511 Locust street.

C. A. Dunn, formerly sales representative of The Prime Manufacturing Company, has been appointed manager of sales of The Weldless Tube Company, Wooster, Ohio.

C. S. Sale, since 1918 assistant to the president of the Railway Car Manufacturers' Association, New York City, has resigned to

accept an appointment with the American Car & Foundry Company, 165 Broadway, New York City.

The Production Engineering Corporation, Canastota, N. Y., has been incorporated to take over the business of the Marvin & Casler Company, Canastota. This corporation will continue to manufacture and sell the Casler tools for machine shops.

The Union Asbestos & Rubber Company has moved its factory to 351 East Ohio street, Chicago. The general office of the company will be located at the factory and the present offices at 231 South Wells street will be retained as the sales offices of the organization.

Lawrence F. Whitney has joined the New England sales organization of the Reading Iron Company, Reading, Pa. Mr. Whitney will assist the district sales manager for New England. He will be located in the company's district office at 161 Devonshire street, Boston, Mass.

H. J. Titus, until recently with the American Locomotive Company, at Paterson, N. J., and George H. Zouck, until recently mechanical engineer with W. H. Marshall, have joined the Franklin Railway Supply Company, Inc., New York, as assistant engineers in its engineering department.

A. A. Taylor, manager of the railroad division of Fairbanks, Morse & Co., with headquarters at Chicago, has resigned to become vice-president and general manager of the Locomotive Firebox Company, manufacturer of Nicholson thermic syphon, with the same headquarters. Mr. Taylor was born at Yates City, Ill., on December 3, 1869, and entered railway service in the office of the vice-president of the Chicago, Burlington & Quincy at Chicago, in 1887. In 1889, he entered the employ of Westinghouse, Church, Kerr & Company, Chicago, in the stoker department, where he remained until 1891, when he entered the sales department of the Morden Frog & Crossing Company, Chicago. From 1896 to 1899, he was employed by the Cable Piano Company, Chicago, and on February 1, 1899, he entered the employ of Fairbanks, Morse & Co., Chicago, as a salesman in the railroad department in the territory east of the Mississippi river and south of the Ohio river. In 1906, he was promoted to manager of that part of the railroad department operating from Chicago, with headquarters at Chicago. In September, 1915, he was promoted to manager of the railroad division including the construction department, in charge of all railroad business in the United States and foreign countries, which position he held up to the time of his resignation. Mr. Taylor has been active in railway supply association work, having served as a director of the National Railway Appliances Association for the last three years.

A. A. Taylor

Edwin L. King has been appointed district sales manager for the Reading Steel Casting Company, Inc., Reading, Pa.; Pratt & Cady Company, division Reading Valve and Fittings Company, division, Bridgeport, Conn., with headquarters at 208 South La Salle street, Chicago, Ill., to succeed M. L. Chase, resigned.

L. R. Phillips has been appointed district sales manager of the Detroit Seamless Steel Tubes Company, Detroit, Mich., and has established an office in Chicago. For the past 20 years Mr. Phillips has been associated with the National Tube Company, 17 of which were with the Chicago office, and the latter three with its St. Louis office.

The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, manufacturers of high-pressure hydraulic presses, pumps, valves, accumulators and intensifiers, has increased its capitalization from $260,000 to $1,200,000. The company's plant will be extended soon by the addition of a new office building, an extension to the erecting shop, wood and pattern department, and the addition of new machines in the machine shop and pattern department.

The Tennessee Coal, Iron & Railroad Company has leased the plant of the Clearfield Steel Company, Birmingham, Ala., heretofore occupied by the Chickasaw Shipbuilding & Car Company, and will use it for the manufacture of railroad cars. It will be known as the Clearfield Car Works of the Tennessee Coal, Iron & Railroad Company.

W. E. Brumble, manager of the Southeastern territory of the Nathan Manufacturing Company, New York, died at his home in Baltimore, Md., on March 2. Mr. Brumble was born at Renovo, Pa., on April 8, 1871. He began railway work as a messenger for the Northern Central in March, 1885, and subsequently served consecutively as yard clerk and fireman. In May, 1894, he was appointed an engineman on the Norfolk & Western and in October, 1901, he entered the services of the Seaboard Air Line as road foreman of engines. He was later promoted to trainmaster of the first division with headquarters at Richmond, Va. From October, 1903, until October, 1916, he was with the Galena Signal Oil Company at Richmond, as mechanical expert, leaving that company to enter the services of the Nathan Manufacturing Company as manager of its Southeastern territory, the position he held at the time of his death.

W. E. Brumble

Edward F. Chaffee, manager of the railroad department of the O. M. Edwards Company, Inc., Syracuse, N. Y., has been elected a vice-president of that company. Mr. Chaffee has been identified with railroad and allied industries since his boyhood. Eighteen years ago he went with the Edwards Company from the New York Central, where he had charge of the passenger car shops at West Albany. His first work for the Edwards Company was in the capacity of eastern sales representative. Six years later he was promoted to manager of the company's railroad department.

E. F. Chaffee

The Sykes Company, with headquarters at Kenosha, Wis., has been organized for the manufacture and sale of gasoline driven rail equipment. The personnel of the new organization includes: C. E. Sykes, Ardmore, Okla., president; C. S. Lynch, Ardmore, Okla., secretary and treasurer; A. M. Russell, Kenosha, Wis., vice-president, formerly president and organizer of the Russell Company, Kenosha, Wis.; J. A. Hennan, Ardmore, Okla.; M. T. Winther, Kenosha, Wis., president of Winther Motors, Inc., and formerly vice-president of the Russell Company; Ray Koehler, formerly chief engineer of the Winther Motors, Inc.; J. F. Sattley, formerly general manager of the central region of the Russell Company, and C. A. Sattley, formerly general manager of the eastern region of the Russell Company.

H. F. Mattern has been appointed sales manager of the Reading Iron Company, Reading, Pa., to succeed E. F. Mishler, whose death occurred on December 11, 1922. Mr. Mattern joined the

Reading Iron Company in 1911 as a salesman, and was given the New England and southern territories to cover. In 1919 he was appointed assistant sales manager.

The Gibb Instrument Company, Bay City, Mich., has taken over, under exclusive license, the manufacture and sale of the automatic and semi-automatic electric arc welding machines developed and heretofore manufactured by the Fred Pabst Company, of Milwaukee, Wis., under various letters patent, and have contracted to act as selling agent for the Pabst line of patented covered electrodes.

Walter C. Doering has resigned as vice-president of the Southern Wheel Company, St. Louis, Mo., to engage in the railway supply business in St. Louis. Among the concerns that Mr. Doering will represent are the American Brake Shoe & Foundry Company, New York; the Bradford Draft Gear Company and the Republic Railway Equipment Company, Chicago. His offices will be located in the Railway Exchange building, St. Louis, Mo.

R. W. Williams has been appointed southwestern district manager for both the Westinghouse Air Brake Company and the Westinghouse Traction Brake Company, with headquarters at St. Louis, Mo., and has also been elected a vice-president of the American Brake Company. Mr. Williams has been connected with the Westinghouse Air Brake Company since April 1, 1902, when he went to Wilmerding as secretary to John F. Miller, now vice-chairman of the board of directors. Mr. Williams was born in Renovo, Pa., in 1878. He attended public school in Williamsport, Pa., and graduated from high school with the class of 1897. He immediately entered the employ of the Pennsylvania Railroad, serving in the freight and maintenance of way departments at Williamsport until he went to the Air Brake Company. After serving in the general offices at Wilmerding for seven years, he was transferred to the southeastern district office in Pittsburgh. In 1910 he went to the Cincinnati office, and two years later was appointed representative and assigned to the Atlanta office. He returned to the Pittsburgh office in September, 1920.

R. W. Williams

Owing to the Cleveland Discount Company having gone into receivership, the Sharon Pressed Steel Company, which was being financed by them, went into voluntary receivership on February 26, in the United States District Court, Pittsburgh. The court has authorized the operation of the plant under W. L. David and Donald Thompson, receivers, who have appointed A. E. Swan, former vice-president and general manager of the Sharon Pressed Steel Company, their agent and attorney.

The Central Steel Company of Massillon, Ohio, manufacturers of alloy steel products for the automotive industry has decided to enlarge its field of activities, by the addition of special alloy steels for railroad service, such as axles, springs and reciprocating parts of locomotives. This department will be under the direction of Irving H. Jones, director of railroad development with office in the Peoples Gas Building, Chicago. Mr. Jones was formerly sales engineer with Joseph T. Ryerson & Son.

Broderick Haskell, Jr., has joined the service staff of the Franklin Railway Supply Company, Inc., New York, as special engineer in connection with the locomotive booster. A. F. Zinkan, who had been for 22 years with the New York Central, much of the time as inspector of locomotive construction, has joined the inspection department of the Franklin Railway Supply Company, Inc., and C. G. Shafer, road foreman of engines of the Southern Railway, is now a service engineer with the Franklin Railway Supply Company. Mr. Shafer's headquarters in his new position are at Memphis, Tenn. C. C. Clabaugh, formerly gang foreman in the Collinwood, Ohio, shops of the New York Central, has been appointed inspector at the plant of the Lima Locomotive Works.

TRADE PUBLICATIONS

WELDING AND CUTTING APPARATUS.—The Alexander Milburn Company, Baltimore, Md., has recently issued catalogue No. 1122 illustrating its line of welding and cutting apparatus. A price list is also included.

ZEOLITE WATER SOFTENERS.—Water softeners in which zeolite is used to remove every trace of lime and magnesia are described in Bulletin 509 recently issued by the Graver Corporation, East Chicago, Ind. The chemistry of Zeolite water softening is described as well as the details of operation of the Graver Zeolite softener.

PORTABLE WOODWORKING MACHINERY.—The Oliver Machinery Company, Grand Rapids, Mich., has issued Bulletin No. 7 descriptive of its line of portable woodworking machinery, which includes motor-driven saw benches, band saws, hand planers and jointers, motor-driven disk sanders, oscillating spindle sanders, oilstone tool grinders, etc.

ELECTRIC MOTORS.—A pamphlet giving instructions for ordering and adjusting repair parts of single-phase motors has recently been issued by the Wagner Electric Corporation, St. Louis, Mo. The causes which may result in the motor failing to start, the brushes failing to release on full load, etc., are explained and instructions are given for correcting these conditions.

ELECTRIC CRANES.—A carefully prepared, 32-page booklet has just been issued by the Whiting Corporation, Harvey, Ill., devoted to the operation and maintenance of Whiting electric cranes. This booklet includes lists of parts together with cuts and diagrams making it easy for the user to order repair parts. A list of valuable "don'ts" for crane operators is given on the last page.

OXY-ACETYLENE OUTFITS.—The Air Reduction Sales Company, New York, has issued two booklets describing and illustrating its line of oxy-acetylene welding and cutting apparatus and equipment, together with its tube welding machines and acetylene generators. The bulletins devote some attention to the history of these subjects, and the use of equipment, and designate the field for which each type of apparatus listed is especially adapted.

COALING AND CINDER PLANTS.—A bulletin has been issued by the Roberts & Schaefer Company, Chicago, describing a one-man operated plant which this company has recently developed to perform the dual functions of coaling locomotives and handling cinders. The bulletin is illustrated with line drawings and photographs showing the plant in elevation and plan, as well as sectional views illustrating its general appearance and operation.

COMBUSCO ASH CONVEYOR.—The Combustion Engineering Corporation, New York, has issued a large size, 12-page, illustrated booklet descriptive of a new type of ash conveyor for power plant and other uses. The text describes the various phases of its operation such as the automatic removal of ashes, the prevention of dust and fumes, the quenching, the maintenance of an air seal in the combustion chamber, etc., while the photographs illustrate numerous sections of typical installations.

TOOLS FOR BOILER MAKING.—The J. Faessler Manufacturing Company, Moberly, Mo., has issued catalogue No. 36 containing a complete descriptive list of all tools produced by this company. Details of roller flue and tube expanders, sectional beading expanders, flue cutters, patch bolt counter-sinking tools, etc., are contained in the catalogue, in each case illustrations, tables of sizes and price lists being included. The company also maintains a department for designing tools for special requirements and difficult tube installations.

WELDING AND CUTTING APPARATUS.—A piece parts catalogue of 15 pages has recently been issued by the Torchweld Equipment Company, Chicago, in which is illustrated and listed a complete line of welding and cutting torches and their parts, gas pressure regulators and gages. The parts shown in the catalogue are for minor repairs, which ordinarily can be made by the user, and to facilitate ordering, each part listed in the catalogue is clearly identified both by part, number and name. Assembled torches are illustrated by sectional drawing with key numbers showing the location of the listed parts.

EQUIPMENT AND SHOPS

Locomotive Orders

THE ATLANTIC COAST LINE has ordered 50 locomotives from the Baldwin Locomotive Works.

THE SEABOARD AIR LINE has ordered 20, 2-8-2 type locomotives from the American Locomotive Company.

THE PHILADELPHIA & READING has ordered 25, 2-8-0 type locomotives from the Baldwin Locomotive Works.

THE CHILEAN STATE RAILWAYS have ordered 25, 2-8-2 type locomotives from the Baldwin Locomotive Works.

THE ELGIN, JOLIET & EASTERN has ordered 10, 2-8-2 type locomotives from the American Locomotive Company.

THE SOUTHERN has ordered 50, 2-8-2 type locomotives and 16, 4-6-2 type locomotives from the American Locomotive Company.

THE GREAT NORTHERN has ordered 28, 2-10-2 type locomotives and 30, 4-8-2 type locomotives from the Baldwin Locomotive Works.

THE BOSTON & MAINE has ordered 10, 2-10-2 type locomotives and 10, 4-6-2 type locomotives from the American Locomotive Company.

THE NEW YORK CENTRAL has ordered for the Pittsburgh & Lake Erie 10, 2-8-2 type locomotives from the American Locomotive Company.

THE LOUISVILLE & NASHVILLE has ordered 30, 2-8-2 type locomotives and 6, 4-6-2 type locomotives from the American Locomotive Company.

THE NEW YORK, NEW HAVEN & HARTFORD has ordered 10, 4-8-2 type and 5, 0-8-0 switching locomotives from the American Locomotive Company.

THE SOUTHERN PACIFIC has ordered 34, 2-10-2 type, and 6, 4-6-2 type, from the Baldwin Locomotive Works, and the 10, 4-8-2 type from the American Locomotive Company.

THE BALTIMORE & OHIO has ordered 25, 2-10-2 type locomotives from the Lima Locomotive Works and 50, 2-10-2 type locomotives from the Baldwin Locomotive Works.

Freight Car Orders

THE MERCHANTS DISPATCH will build 1,500 refrigerator cars in its own shops.

THE CAMBRIA & INDIANA has ordered 1,000, 55-ton hopper cars from the Cambria Steel Company.

THE SKELLY OIL COMPANY has ordered 50, 8,000 gal. capacity tank cars from the Standard Tank Car Company.

THE UNIVERSAL PORTLAND CEMENT COMPANY has ordered 300 all-steel box cars from the American Car & Foundry Company.

THE MIDLAND REFINING COMPANY has ordered 100, 50-ton, 10,000 gal. capacity tank cars from the Standard Tank Car Company.

THE REPUBLIC IRON & STEEL COMPANY has ordered 50 flat bottom gondolas of 70 tons' capacity from the Standard Steel Car Company.

THE BUFFALO & SUSQUEHANNA has ordered 200 all-steel hopper car bodies of 55-tons' capacity, from the Buffalo Steel Car Company.

THE UNITED GAS IMPROVEMENT COMPANY, Philadelphia, Pa., has ordered 150 coal cars of 50 tons' capacity from the American Car & Foundry Co.

THE WHITE EAGLE OIL & REFINING CO., Wichita, Kan., has ordered 100 8,000-gal. capacity tank cars from the Pennsylvania Tank Car Company.

THE SEABOARD AIR LINE has ordered 1,000 box cars from the Pressed Steel Car Company, 800 gondola cars from the Standard Steel Car Company and 200 gondola cars from the Newport News Shipbuilding Corporation.

THE CHESAPEAKE & OHIO has ordered 1,000 hopper cars of 70 tons' capacity from the American Car & Foundry Co., and 1,000 from the Standard Steel Car Company.

THE HILLMAN COAL & COKE COMPANY has ordered 300 hopper cars of 70-tons' capacity from the Pressed Steel Car Company. These are in addition to the previous order for 300 cars noted in the March *Railway Mechanical Engineer.*

THE ILLINOIS CENTRAL has ordered 1,000 automobile cars from the American Car & Foundry Company, 500 automobile cars from the Western Steel Car & Foundry Company and 500 automobile-furniture cars from the Mt. Vernon Car Manufacturing Company.

THE TEXAS COMPANY has ordered 200 tank cars of 8,000 gal. capacity from the Pennsylvania Tank Car Company, 50 tank cars of 8,000 gal. capacity from the Chicago Steel Company and 50 tank cars of 10,000 gal. capacity from the Standard Tank Car Company.

THE LOUISVILLE & NASHVILLE has ordered 6,000 hopper cars of 55 tons' capacity from the Pressed Steel Car Company, 1,000 ventilated box cars of 40 tons' capacity from the Mt. Vernon Car Manufacturing Company and 1,000 ventilated box cars of 40 tons' capacity from the Chickasaw Shipbuilding Company.

THE NEW YORK CENTRAL has ordered 100 Hart convertible ballast cars of 50 tons' capacity from the American Car & Foundry Company for use on the Michigan Central. The company also has placed orders for 4,000 cars as follows: To the Standard Steel Car Company 1,500 cars of 70 tons' capacity and 500 all-steel box cars of 50 tons' capacity; American Car & Foundry Company, 1,500 all-steel box cars of 50 tons' capacity, and the Pressed Steel Car Company, 500 cars of 70 tons' capacity.

THE SOUTHERN RAILWAY has ordered 1,365 composite hopper cars and 1,500 box cars from the American Car & Foundry Company; 1,500 composite hopper cars and 1,000 box cars from the Standard Steel Car Company; 570 box cars from the Mt. Vernon Car Manufacturing Company, and 2,000 coal cars from its Lenoir Car Works. All the box cars are 36 ft. long. An order has also been given for 200 stock cars to the Kilby Car & Foundry Company.

Passenger Car Orders

THE NEW YORK CENTRAL has ordered 6 coaches from the American Car & Foundry Company. These are for use on the Peoria & Eastern. An order has also been given to the Standard Steel Car Company for 8 combination baggage and mail cars for use on the Michigan Central and for 1 combination baggage and mail car for use on the Toledo & Ohio Central.

Machinery and Tools

THE UNION PACIFIC has placed an order for a 200-ton locomotive lifting crane.

THE WESTERN MARYLAND has ordered from Joseph T. Ryerson Son, Inc., a complete equipment for the repairing of locomotive flues.

THE PERE MARQUETTE has ordered one 200-ton, five 15-ton and two 10-ton electric traveling cranes for use in its shops at Grand Rapids, Mich., from the Shaw Crane Company.

THE ATCHISON, TOPEKA & SANTA FE is inquiring for one 16-in. by 8-ft. engine lathe, one 14-in. heavy duty slotting machine with longitudinal and cross feeds and circular table feed, two vertical high power 24-in. drilling machines with compound table and capacity to drill 4-in. holes in steel, also one 5-ft. plain heavy duty type motor driven radial drill.

THE NORFOLK & WESTERN is inquiring for a number of machine tools including the following: A four-spindle planer type milling machine; a slab milling machine; 24 in. vertical turret lathe; 600-ton double end car wheel press; 72 in. plain radial drill; 60 in. plain radial drill; 48 in. radial drill; 84 in. plain radial drill; 72 in. vertical boring mill; 48 in. car wheel borer; a standard double head, center drive, car axle lathe; 2½ in. hollow spindle turret lathe; four, 20 in. by 5 ft. center engine lathes with taper attachment; two, 24 in. by 6 ft. center heavy duty lathes with taper attachment; 24 in. heavy duty lathe with taper attachment; 48 in. by 10 ft. center heavy duty lathe; 2½ in. flat head turret lathe; 16 ft. sensitive drill press; 36 in. by 36 in. by 16 ft. two-head

planer; 42 in. car wheel lathe; 36 in. vertical drill press; 15 in. by 18 in. drill slotter; 26 in. by 96 in. plain grinding machine; one internal grinding machine; a plain external cylindrical grinding machine, and a 32 in. Newton plank planer.

Shops and Terminals

MISSOURI, KANSAS & TEXAS.—This company has awarded a contract to the Graver Corporation, Chicago, for the construction of 24 water treating plants along its lines.

CHICAGO & EASTERN ILLINOIS.—This company contemplates the construction of a new roundhouse and shop buildings at Evansville, Ind., to cost approximately $3,000,000.

TOLEDO, PEORIA & WESTERN.—This company has awarded a contract to the Ogle Construction Company, Chicago, for the construction of a 100-ton capacity frame coaling station at Fairbury, Ill.

ILLINOIS CENTRAL.—This company contemplates the construction of a brick and steel car repair shop and other additions to the shop facilities of the Burnside shops at Chicago to cost approximately $3,000,000.

MISSOURI PACIFIC.—This company has awarded a contract to the Railroad Water & Coal Handling Company, Chicago, for the construction of a 15,000 gal. per hour capacity water treating plant at Benton, Mo.

CHICAGO, ROCK ISLAND AND PACIFIC.—This company has awarded a contract to the J. A. Benson Construction Company, Des Moines, Iowa, for the construction of a 13-stall roundhouse at Valley Junction, Iowa.

TOLEDO TERMINAL RAILWAY COMPANY.—This company has awarded a contract to the Ogle Construction Co. for the erection of a 200-ton, two-track, reinforced concrete coaling and sanding station at Toledo, Ohio.

CHICAGO, ROCK ISLAND & GULF.—This company has awarded a contract to the Railroad Water & Coal Handling Company, Chicago, for the construction of a 300-ton, 2-track coaling and sanding station at Amarillo, Texas.

NEW YORK CENTRAL.—This company has awarded a contract to the Roberts & Schaefer Company, Chicago, for the construction of a 100-ton two track, reinforced concrete automatic electrically operated locomotive coaling station at North Judson, Ind.

CENTRAL OF GEORGIA.—This company has awarded a contract to the Ogle Construction Company, Chicago, for the erection of a reinforced concrete electrically-operated coaling station which will provide for ground and overhead storage of 9,000 tons and 600 tons of coal, respectively, and the storage of 200 tons of wet sand and 35 tons of dry sand, at Macon, Ga.

ST. LOUIS-SAN FRANCISCO.—This company plans the construction of new shop buildings at St. Louis, Mo., and at East Thomas, Ala. Each group will be of concrete, brick and steel construction and will consist of a roundhouse, machine shop, power house, mill shop, car repair shop and storeroom. The cost of the new facilities will be approximately $500,000 at each place.

ATCHISON, TOPEKA & SANTA FE.—This company will construct extensions to the shop facilities at San Bernardino, Cal., at an approximate cost of $1,250,000. A portion of the work to cost $750,000 will be undertaken this year. Plans include also the rearrangement of the machine, boiler and paint shops. A 120-ft. turntable to cost approximately $60,000 will also be constructed.

ST. LOUIS-SAN FRANCISCO.—This company has awarded a contract to John M. Olsen, Springfield, Mo., for the construction of a mill shop building at Enid, Okla. This company has also awarded a contract to the Jarrett Construction Company, Springfield, Mo., for a four-stall addition to the roundhouse at West Tulsa, Okla., and a five-stall addition to the roundhouse at Ft. Scott, Kan.

SOUTHERN PACIFIC.—This company contemplates the construction of additional shop facilities at Los Angeles, Cal., to cost approximately $1,000,000. The buildings to be constructed include a car repair shop, a forge and blacksmith shop, a one-story boiler shop, a new locomotive house and related facilities. The company is now constructing an acetylene generator plant with a distributing system throughout the entire yards and has nearly completed a two-story oil house, 34 ft. by 86 ft., with a loading platform, 42 ft. by 100 ft.

PERSONAL MENTION

General

J. HAINEN, assistant to the vice-president, mechanical, of the Southern, with headquarters at Washington, D. C., has resigned.

B. PERKINS has been appointed fuel agent of the Kansas division of the Union Pacific, with headquarters at Armstrong, Kansas City, Kan.

C. E. BROOKS, mechanical assistant in the locomotive department of the Canadian National, has been appointed chief of motive power with headquarters at Montreal.

E. A. RAUSCHART, master mechanic of the Montour railroad at Coraopolis, Pa., has been promoted to mechanical superintendent, the office of master mechanic having been abolished.

W. U. APPLETON, general superintendent of rolling stock of the Canadian National, has been appointed general superintendent of the Atlantic region with headquarters at Moncton, N. B.

W. E. BARNES, master mechanic of the Canadian National at Moncton, N. B., has been appointed superintendent of motive power of the Atlantic region with the same headquarters.

W. G. BLACK, master mechanic of the New York, Chicago & St. Louis, with headquarters at Chicago, has been promoted to superintendent of motive power, with headquarters at Cleveland, Ohio, succeeding A. R. Ayers.

J. C. GARDEN, general superintendent of motive power and car department of the Grand Trunk with headquarters at Montreal, has been appointed general superintendent of motive power of the Central region of the Canadian National with headquarters at Toronto.

P. W. KIEFER, assistant engineer in the mechanical department of the New York Central, has been appointed to the new office of assistant engineer of rolling stock, with headquarters at New York. H. I. Wood, chief draftsman, has been appointed assistant engineer to succeed Mr. Kiefer.

C. F. NEEDHAM, assistant to the general superintendent of the motive power and car departments of the Grand Trunk, lines east of the Detroit and St. Clair rivers, has been appointed assistant to the general manager of the Central region of the Canadian National with headquarters at Toronto, Ont.

G. O'CONNELL has been appointed superintendent of work equipment of the Canadian National with headquarters at Toronto, Ont. W. H. Secord, supervisor of work equipment with headquarters at Toronto, has been promoted to assistant superintendent of work equipment with the same headquarters.

E. M. SWEETMAN, superintendent of motive power, lines west of the Southern with headquarters at Cincinnati, Ohio, has been transferred in a similar capacity to the lines east with headquarters at Charlotte, N. C., succeeding W. F. Kaderly, resigned. Frank Johnson, master mechanic at Ferguson, Ky., has been promoted to superintendent of motive power, lines west, succeeding Mr. Sweetman.

JAMES E. DAVENPORT has been appointed superintendent of fuel and locomotive performance of the New York Central with headquarters at Utica, N. Y., succeeding Robert Collett, who has resigned to enter the service of another company. Mr. Davenport was born on October 8, 1887, at Charlestown, W. Va., attended the Georgia School of Technology in 1908 and 1909 and entered railway service on August 1 of the latter year as a special apprentice in the mechanical department of the New York Central. In April, 1912, he was appointed enginehouse foreman and in June, 1914, was advanced to engineer in charge of a dynamometer car. In June, 1917, he was promoted to trainmaster of the Harlem division and in November, 1918, was transferred in a similar capacity to the Mohawk division. In June, 1920, he was appointed engineer of dynomometer tests and served in that capacity until the time of his recent appointment.

ROBERT COLLETT, whose appointment as fuel agent of the St. Louis-San Francisco was announced in the February *Railway Mechanical Engineer*, page 138, entered railway service in 1895 as

a locomotive fireman for the St. Louis-San Francisco. Five years later he was promoted to locomotive engineman and in 1905 was appointed road foreman of engines. In 1909 he became superintendent of locomotive fuel service and held that position until 1914, when he resigned to become assistant manager of the railway lubricating department of the Pierce Oil Corporation, St. Louis, Mo. From July 1, 1918, to March 1, 1920, he was assistant manager of the fuel conservation section of the U. S. Railroad Administration in charge of fuel conservation in the Eastern region. Upon the return of the roads to private operation, he became superintendent of fuel and locomotive performance of the New York Central and held that position until he re-entered the service of the St. Louis-San Francisco, as noted above.

W. D. Robb, ranking vice-president of the Grand Trunk, has been appointed vice-president in charge of natural resources, developments and colonization of the Canadian National, with which the Grand Trunk has been recently consolidated. He was born on September 23, 1857, at Longueuil, Que., and was educated at Sherbrooke Academy, Sherbrooke, Que. He entered railway service in 1871 as an apprentice in the motive power department at Port Levi, Que. From 1874 to 1883 he was apprentice in the same department at Montreal. He then served for a few months as night roundhouse foreman at Port St. Charles and was then appointed foreman at Belleville, Ont. In 1897 he was appointed master mechanic at London, Ont., and eight months later was transferred in a similar capacity to Toronto. In 1901 and 1902 he served as acting superintendent of motive power at Montreal and from 1902 to 1917 as superintendent of motive power. In the latter year he was appointed vice-president in charge of motive power and car department and the following year was promoted to vice-president in charge of operation.

A. R. Ayers has been promoted to assistant general manager of the New York, Chicago & St. Louis. Mr. Ayers was born on October 26, 1878, at Toledo, Ohio. He was graduated from Cornell University in 1900, and then entered railway service as a special apprentice on the Lake Shore & Michigan Southern. He was made special inspector in 1903, and held this position for two years, when he was promoted to night enginehouse foreman. He was promoted to assistant general foreman of the Collinwood locomotive shops in 1906, and a year later was made superintendent of the shops at Elkhart, Ind. He was promoted to assistant superintendent of the Collinwood locomotive shops in 1908, and a year later to assistant master mechanic at Elkhart. He was appointed mechanical engineer in 1910, and held this position for one year when he was advanced to general mechanical engineer of the New York Central, lines west of Buffalo. In May, 1915, he was promoted to engineer of rolling stock, serving in this capacity until October, 1916, when he was appointed superintendent of motive power of the New York, Chicago & St. Louis, with headquarters at Cleveland, Ohio. He held this position at the time of his recent promotion to assistant general manager, with the same headquarters.

Master Mechanics and Road Foremen

T. C. Baldwin, superintendent of shops of the New York, Chicago & St. Louis, at Conneaut, Ohio, has been promoted to master mechanic, with headquarters at Chicago, succeeding Mr. Black.

George T. Strong has been appointed master mechanic on the New River division of the Virginian with headquarters at Princeton, W. Va., succeeding G. H. Langton, resigned. Frank Welboan has been appointed shop superintendent at Princeton.

C. S. Branch, superintendent in charge of operation of the Chicago, Peoria & St. Louis, with headquarters at Springfield, Ill., has been appointed master mechanic of the Chicago & Alton with headquarters at Bloomington, Ill., succeeding W. H. Kerchner, resigned.

J. A. Wilking, master mechanic of the Southern at Chattanooga, Tenn., has succeeded Mr. Johnson as master mechanic at Ferguson and L. C. Schults, general foreman at Danville, Ky., has been promoted to master mechanic at Chattanooga. J. J. Robinson, master mechanic at Alexandria, Va., and M. D. Stewart, master mechanic at Bristol, Va., have changed places.

A. G. Akans, road foreman of engines of the Southern with headquarters at Sheffield, Ala., has been transferred to Knoxville, Tenn., succeeding G. G. Shafer, who has resigned. J. P. Russell, road foreman of engines, with headquarters at Birmingham, Ala., has been transferred to Sheffield, succeeding Mr. Akans, J. Sims, road foreman of engines between Birmingham, Ala., and Columbus, Miss., with headquarters at Birmingham, has been transferred to the district between Birmingham and Atlanta, with the same headquarters. J. E. Hardy has been promoted to road foreman of engines, with headquarters at Birmingham, Ala., succeeding Mr. Sims.

Car Department

G. E. Smart, mechanical assistant in the car department of the Canadian National has been appointed chief of car equipment with headquarters at Montreal.

G. E. McCoy, master car builder of the Canadian National, with headquarters at Moncton, N. B., has been appointed superintendent of car equipment of the Atlantic region with the same headquarters.

J. Coleman, assistant to the general superintendent of the motive power and car departments of the Grand Trunk lines east of the Detroit and St. Clair rivers, with headquarters at Montreal, has been appointed general superintendent of the car department of the Canadian National, Central region, with headquarters at Toronto.

Purchasing and Stores

R. C. Vaughan, has been appointed director of purchases and stores of the Canadian National with headquarters at Montreal. Mr. Vaughan was born on December 1, 1883, at Toronto, Ont. He received a high school education and entered railway service in 1898 with the Canadian Pacific. He later left this company to go with the Grand Trunk. From 1903 to 1910 he was with various predecessors of the Canadian National in various departments. From 1910 to 1918 he was assistant to the third vice-president of the Canadian Northern. From 1918 to December, 1920, he was assistant to the president of the Canadian National. From the latter date until the time of his recent appointment he served as vice-president of purchases and stores.

R. C. Vaughan

W. A. Hopkins, supply agent of the Missouri Pacific with headquarters at St. Louis, has been promoted to general purchasing agent, with the same headquarters, succeeding C. A. How, deceased. L. P. Krampf has been appointed supply agent, with headquarters at St. Louis, succeeding Mr. Hopkins.

Obituary

C. A. How, general purchasing agent of the Missouri Pacific, died on March 5 at St. Louis, Mo. Mr. How was born in 1866 at Brooklyn, N. Y. He entered railway service in 1884, as a file clerk for the Union Pacific at Council Bluffs, Ia. A year later he entered the service of the Chicago, Burlington & Quincy at Omaha, Neb., as a clerk, being transferred a few years later to Plattsmouth, Neb., where he was promoted to chief clerk to the supply agent. He was promoted to supply agent in charge of the Hannibal and St. Joseph divisions in 1899, and was promoted to division superintendent in 1904. Later in that year he entered the service of a railway supply company, in which work he was engaged for one year, when he resigned and was appointed purchasing agent of the Wabash, with headquarters at St. Louis, Mo. He was appointed supply agent of the Missouri Pacific, with the same headquarters in 1910, and in 1911 was promoted to general purchasing agent with the same headquarters. During Federal control he served as chairman of the Regional Purchasing Committee of the Southwestern region, with headquarters at St. Louis, returning to his position as general purchasing agent of the Missouri Pacific at the expiration of Federal control.